Appendix II and the potential historic archaeological sites listed in Appendix III, a grand total of 1,147 historic sites are located within the project corridor; this number should be somewhat lower, due to the cross-listing of several sites in both Appendices. By combining these data bases, it can be seen that the first three periods are under-represented within the project corridor: there are only four sites from the 1630 to 1730 period, ten from the 1730 to 1770 period, and 50 from the 1770 to 1830 period. By contrast, there are at least 565 historic sites dating from the 1830 to 1880 period, and 485 dating to the 1880 to 1940+ period. These results suggest that the last two periods can be studied best from existing standing structures supplimented by archaeological investigations, while the first three periods can best be examined by archaeological inquiry, due to the paucity of sites, standing structures, and functional types dating from prior to the mid-nineteenth century in the project corridor.

PREDICTIVE MODELS

The previous section of this report presented the inventories of known, and previously recorded, prehistoric and historic archaeological sites. As was noted earlier, the sites recorded in the state records do not represent all the cultural resources in the study area, or even an unbiased sample. Consequently, it is necessary to use projections of potential archaeological site locations (predictive models) to make management and planning decisions about cultural resources. This section describes the uses of predictive models in prehistoric and historic archaeology and applies various types of predictive models to the study area.

PREHISTORIC SITES

Predictive models must be applied to the study of prehistoric archaeological resources for a number of reasons. First, a complete inventory of all prehistoric archaeological sites is not possible due to cost limitations. Also, archaeological site discovery often entails at least partial site destruction. Thus, it is necessary to develop predictions of where various types of prehistoric archaeological sites of various ages are likely to be found.

Development of these predictions for prehistoric sites can be accomplished in a number of different ways (Kohler 1988). One method utilizes detailed analyses of modern resource distributions and studies of living hunter-gatherer populations to predict what sorts of places similar populations might have inhabited in the past (eg., Jochim 1976). Because of the detailed nature of the required resource distribution analyses and the limitations of the currently available paleoenvironmental data base, modern environments must be used to develop the models. While these models have been applied to, and work well for, late prehistoric groups (eg., Thomas et al. 1975), the projections of these models and their predictions into the more distant past, is risky, at best, as noted by Binford (1978). Also, the predictions generated from the application of these models in the Middle Atlantic Coastal Plain (Cameron 1976) have been contradicted by empirical data from archaeological sites

(Custer, Stiner and Watson 1983; McNamara 1982). Another method of generating predictive models uses samples of modern site distributions to develop quantitative assessments of densities of site per unit areas of various size and configuration (Wilke and Thompson 1977; Luckenbach and Clark 1982). These studies do not distinguish among the various classes of archaeological sites encountered and, therefore, such studies are not appropriate for all kinds of resource management because they ignore the cultural content of archaeological sites as well as the potential to yield useful data which establishes these sites' significance (Raab and Klinger 1977). Also, these studies do not link the site densities, with locational data which allow the plotting of areas of differential site densities.

The alternative to the approaches noted above is the traditional approach to predictive modelling developed and utilized by William M. Gardner and his students at Catholic University. Gardner's (1978, 1982) studies consider the existing data on site locations for various classes of sites from different time periods. Correlations between site locations and environmental settings are then determined. If controlled samples are available, statistical analyses may be used (Custer 1980; Wells et al. 1981; Custer and Galasso 1983; Eveleigh et al. 1983); however, if uncontrolled samples are utilized the analyses are more impressionistic (Gardner 1978, 1982; Custer and Wallace 1982). Whatever the type of analysis, a series of descriptions of typical site locations are developed. These descriptions may be in the form of listings of significant variables (Gardner

1978; Cunningham 1983), narrative descriptions of typical site locations (Stewart 1981; Wall 1981; Tolley 1983), diagrams of site locations (Hoffman and Foss 1980; Custer and Wallace 1982; Custer 1983a, 1983b, 1983c), descriptions of site locations using quantitative data (Hughes and Weissman 1982), or quantitative projections of numbers and types of sites within varied environmental zones (Custer 1980; Custer and Galasso 1983). No matter what their form, these predictions can then be used for resource management and further research and testing. This approach will be used in this study and is preferable to the other approached for management purposes because it considers the cultural content of sites and specifically predicts their locations.

The approach to predictive model generation noted above can be applied to the study area at a variety of levels. The most general level is to use the initial predictive models developed for the Delaware plan for the management of prehistoric cultural resources (Custer 1983b), a similar plan developed for the Upper Delmarva region of Maryland (Custer 1983c and several smaller regional management plans (Custer and De Santis 1986; Custer 1983b, 1987). In these management plans, a series of diagrams showing relationships among sites and typical site locations were formulated. Also, tabular summary descriptions of typical site locations were prepared. The tabular summaries and diagrams were then combined to define study units for each of the major cultural periods. In order to apply these models to the present study, the proposed highway corridor was plotted in relation to the study areas from the state plan (Custer 1983b), the Atlantic Coast regional plan (Custer 1987), and the southwestern Delaware regional plan (Custer 1989) and the relevant diagrams and descriptions of typical locations noted. The relevant site models and study units are described below for each cultural period. Site distributions within the study area will also be discussed and Figure 15 shows the distribution of known sites in the study area.

For the Paleo-Indian Period, the entire project area falls within a study area that has a low data quality and a low probability for all types of Paleo-Indian sites (Custer 1983b; Custer 1984c). Figure 17 shows the typical environmental locations for Paleo-Indian sites that can be expected to occur in the study area. These sites include base camps (habitation sites) and hunting and maintenance sites where various resources were procured. Generally, this model would be most applicable in the drainage divide area although similar patterns would be seen with a lower frequency throughout the project area (Figure 18). Figure 19 shows a "serial" model of group movements (Custer, Cavallo, and Stewart 1983) that would most likely have linked sets of the site locations noted in Figure 17. The serial model assumes that Paleo-Indian groups would move from base camp to base camp with movements dictated by resource availability. As groups moved, various hunting locales and lithic resources would be used on a serial basis. Application of the serial model is based on the fact that lithic resources within the project area are small, scattered, and numerous (Custer and Galasso 1980).

FIGURE 17

Paleo-Indian/Archaic Settlement Pattern

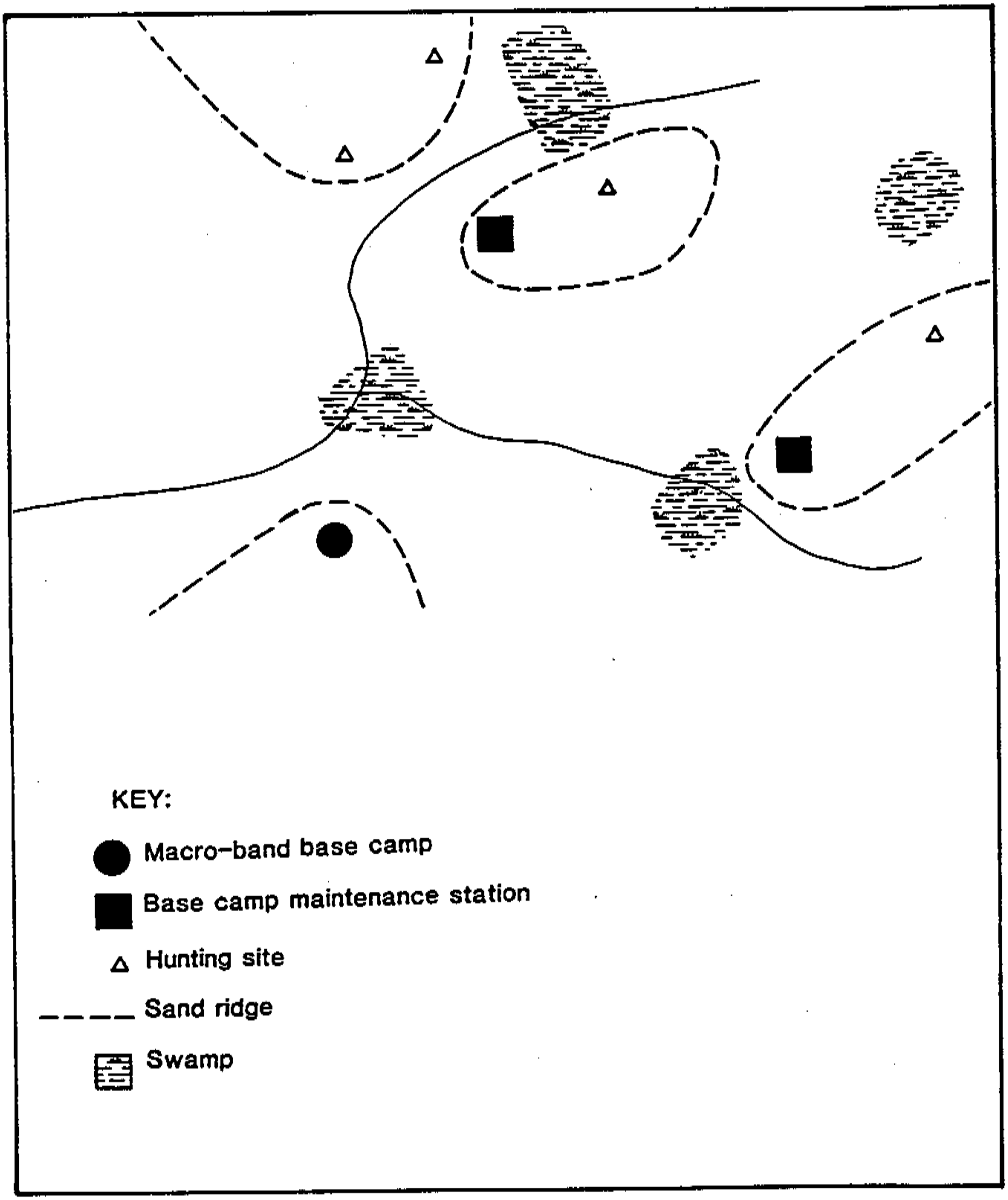
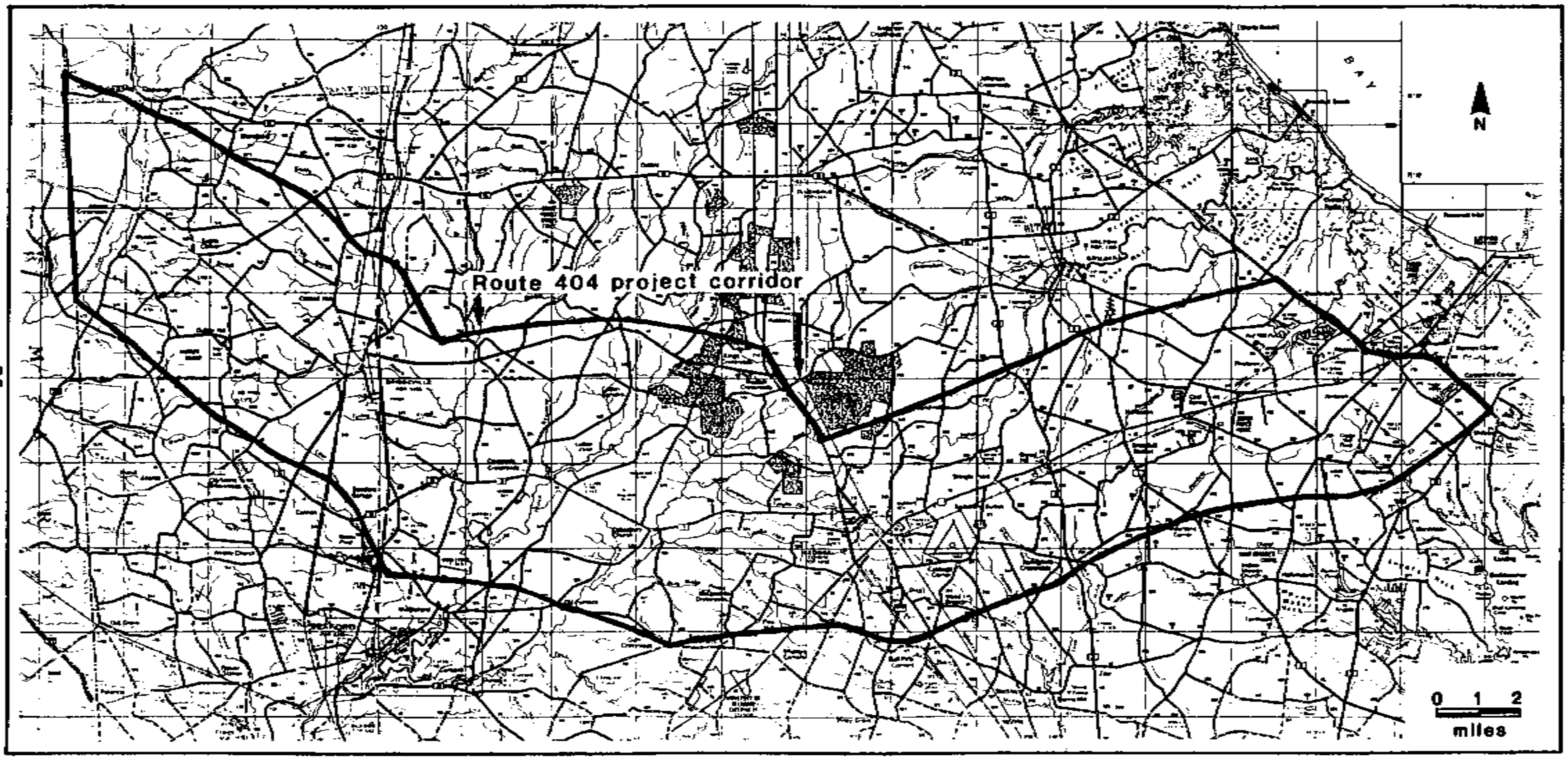


FIGURE 18

Predictive Models of Paleo-Indian Site Locations in the Project Corridor



* Site locations on file at DelDOT and U of D.

FIGURE 19

Serial Settlement/Lithic Utilization Model

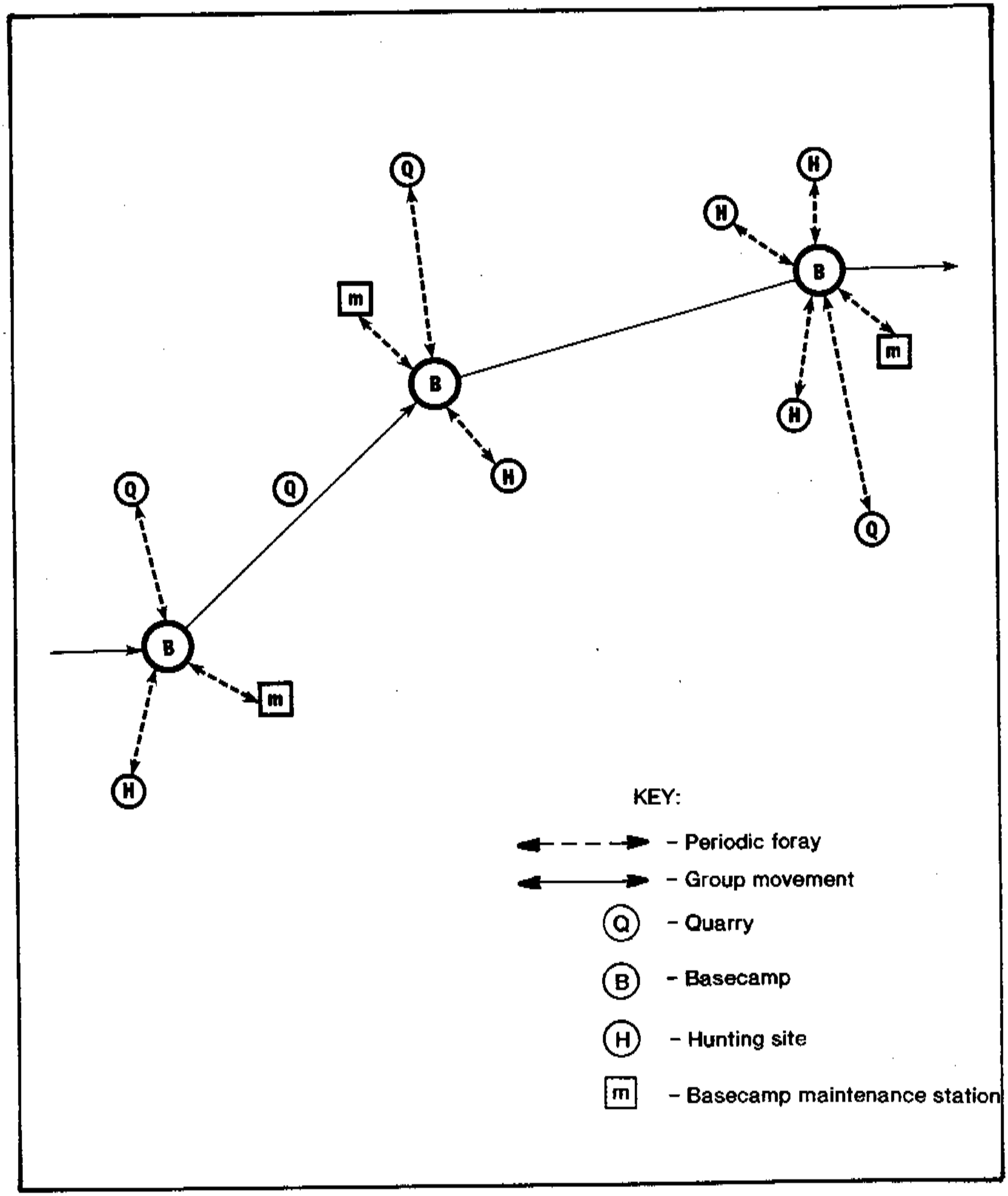


TABLE 9

PALEO-INDIAN SITE LOCATIONS

Site Types	Locations
Base camp	well-drained ridge in areas of maximum habitat overlap
Base camp maintenance station	game attractive locale close to base camp (swamps, bay/basin)
Hunting site	game attractive locales away from base camp (swamps, bay/basin)

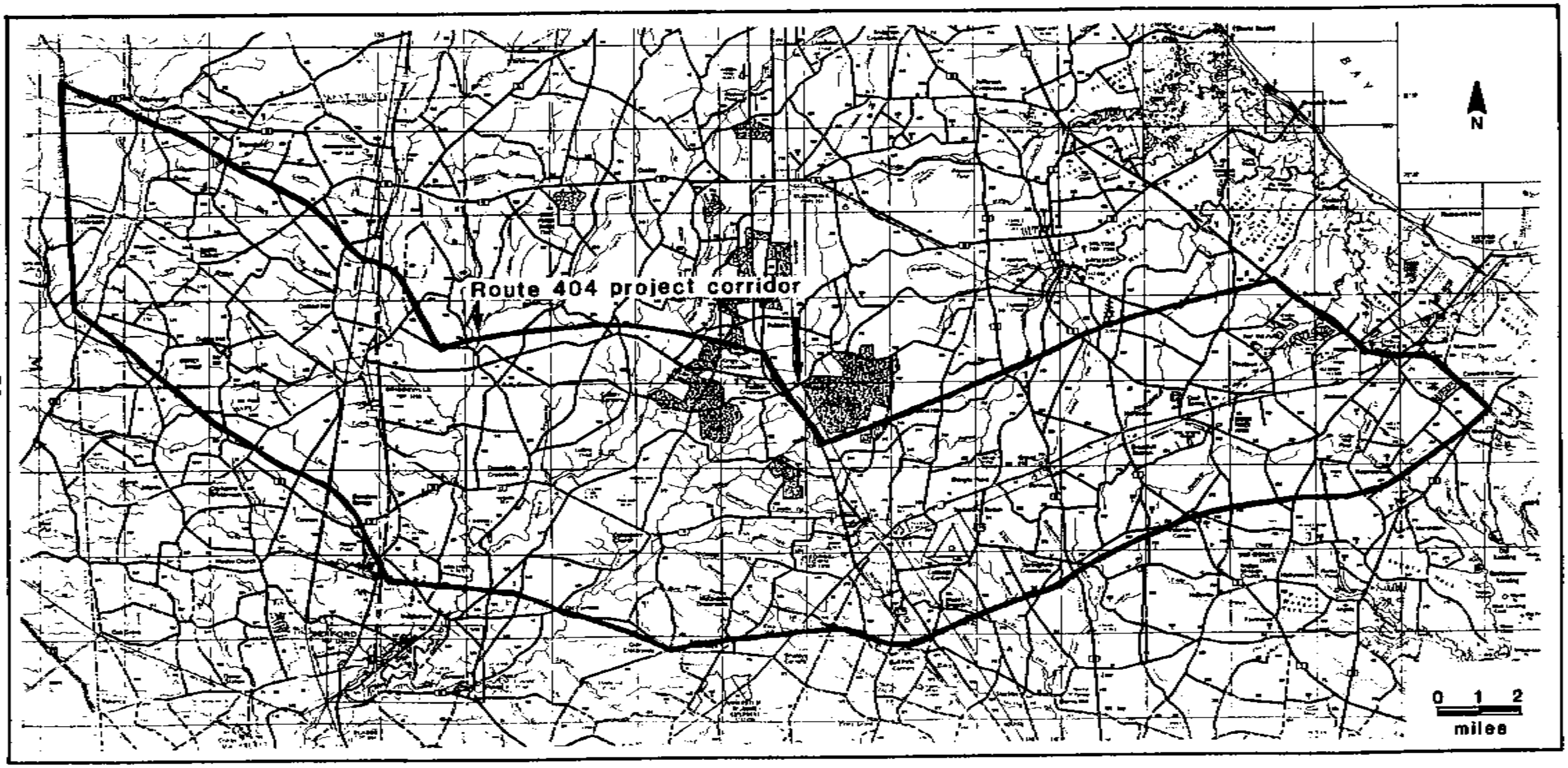
Table 9 provides summary descriptions of typical Paleo-Indian site locations for the project area.

The site location model (Figure 17) and the summary site location descriptions noted in Table 9 would also apply to the Archaic Period in the study area because the limited site data (Figure 20) and other studies (Custer 1986a, 1989) show that there were only limited changes in settlement patterns during the Archaic.

Woodland I sites are the most common sites in the study area (Figure 21), and for the most part, the locational characteristics of these sites are not that different from those of earlier sites. Nevertheless, it can be noted that Woodland I settlement in the study area, especially along the Nanticoke drainage, is significantly more intensive than that of earlier time periods (Figure 22). The presence of ceramics also allows the identification of individual cultural complexes at sites, and maps of sites for each Woodland I cultural complexes on the general Nanticoke drainage are shown in Figures 23-26.

FIGURE 20

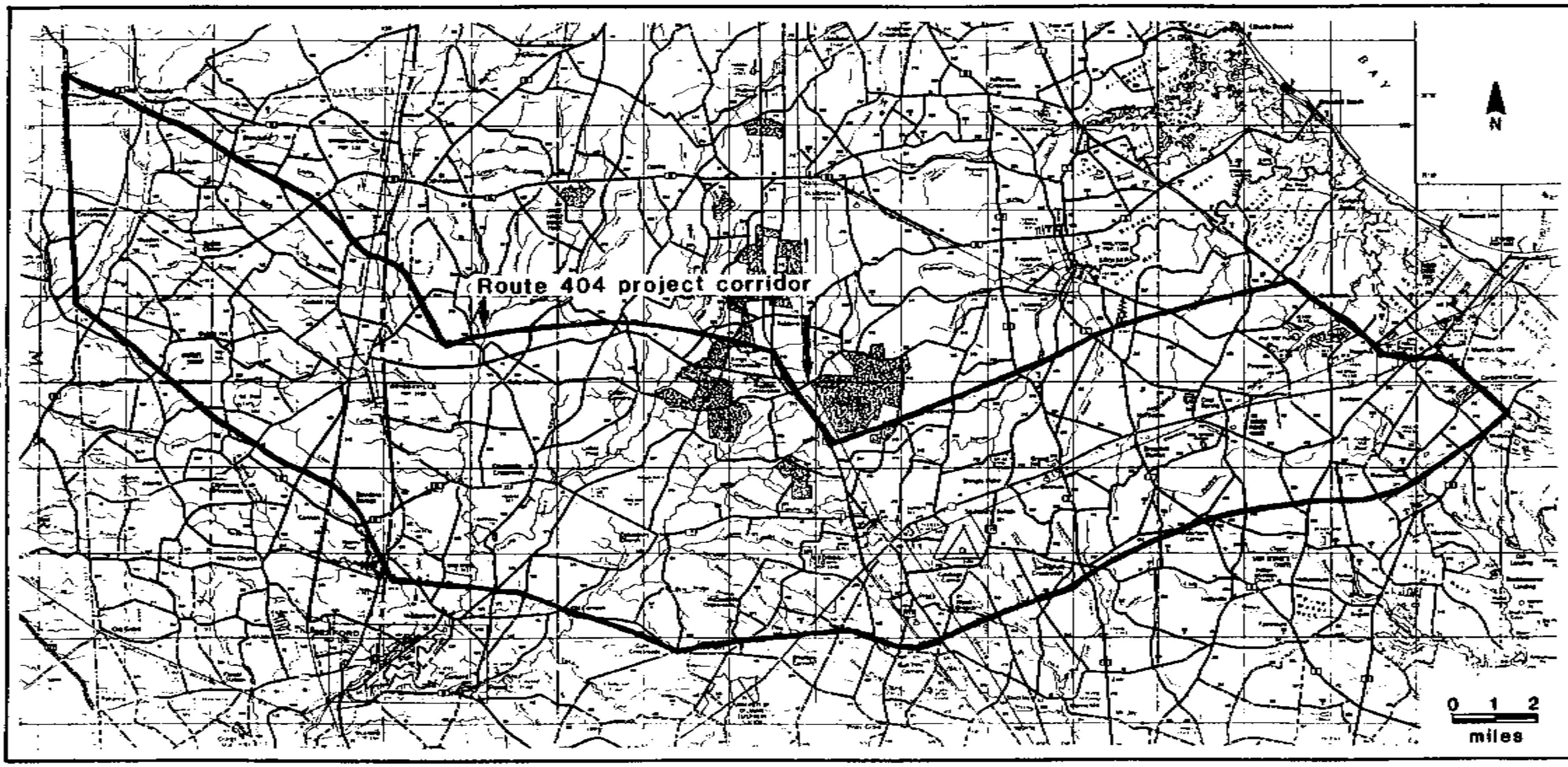
Archaic Period Site Location Model



* Site locations on file at DelDOT and U of D.

FIGURE 21

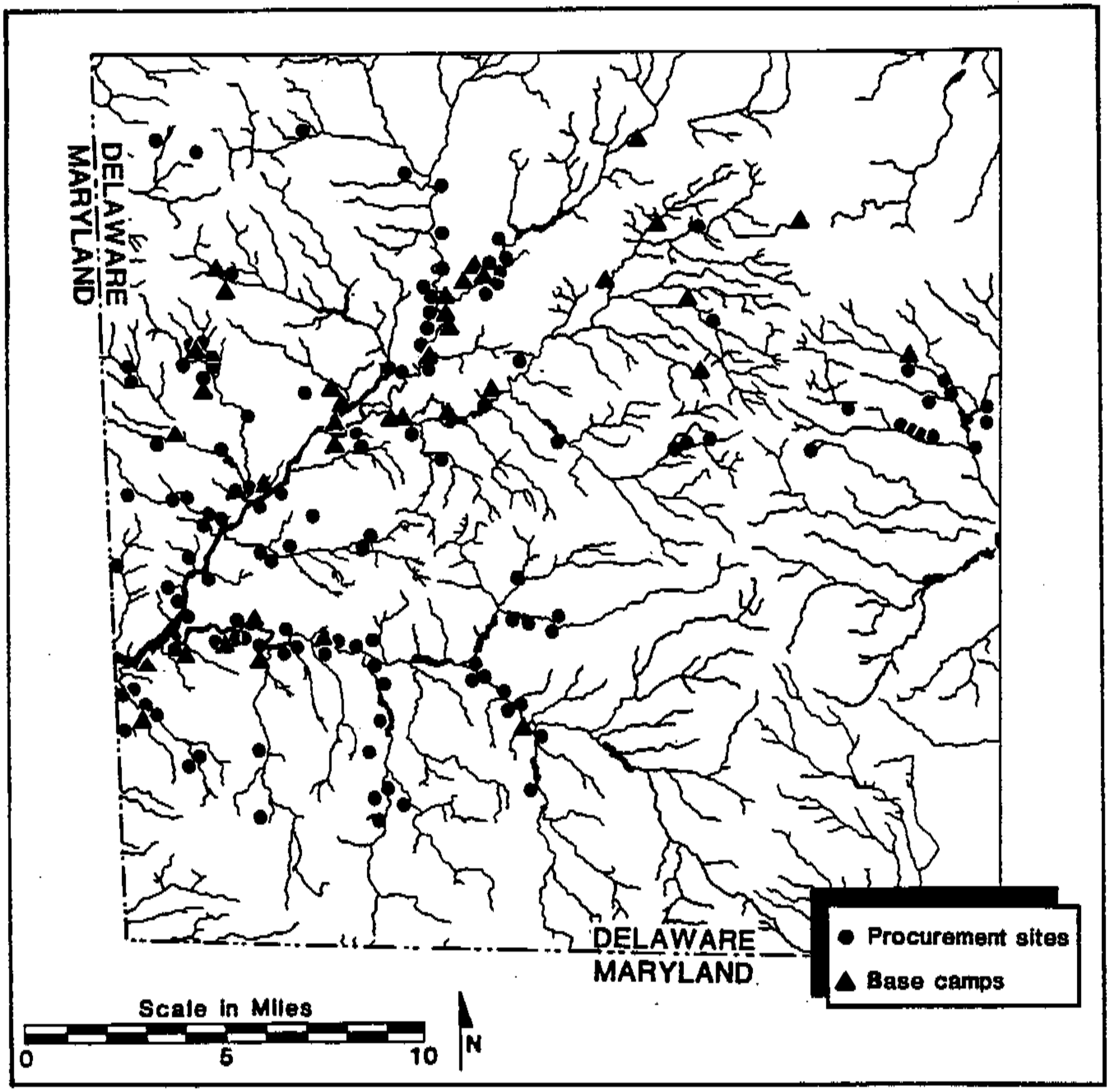
Woodland I Period Site Location Model



* Site locations on file at DelDOT and U of D.

FIGURE 22

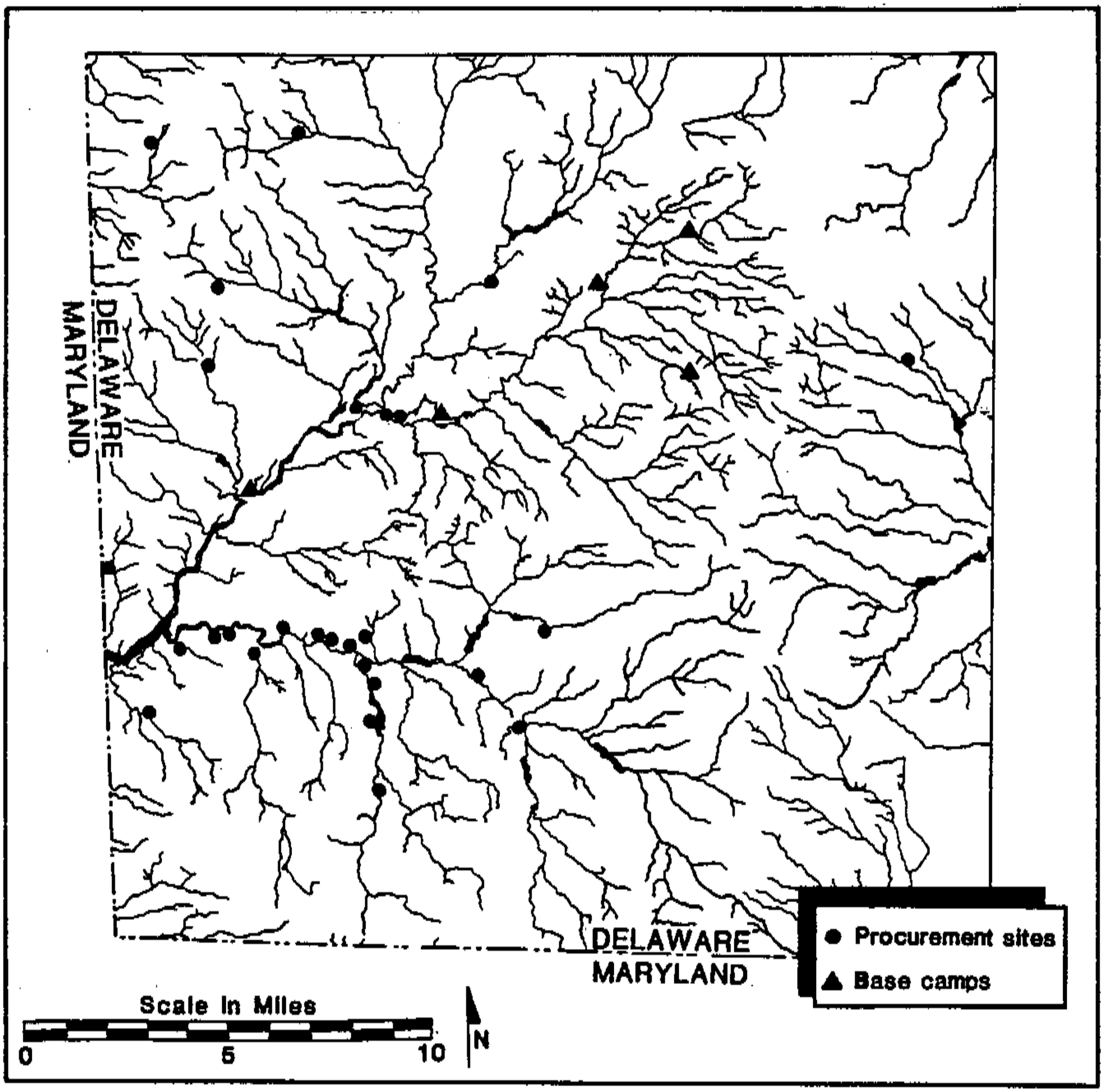
Woodland I Site Locations from the General Nanticoke Drainage



There are numerous Clyde Farm Complex sites (Figure 23) in the study area. The base camp distribution is the same as that of the general Woodland I time period. However, there does seem to be an especially large number of Clyde Farm Complex procurement sites along

FIGURE 23

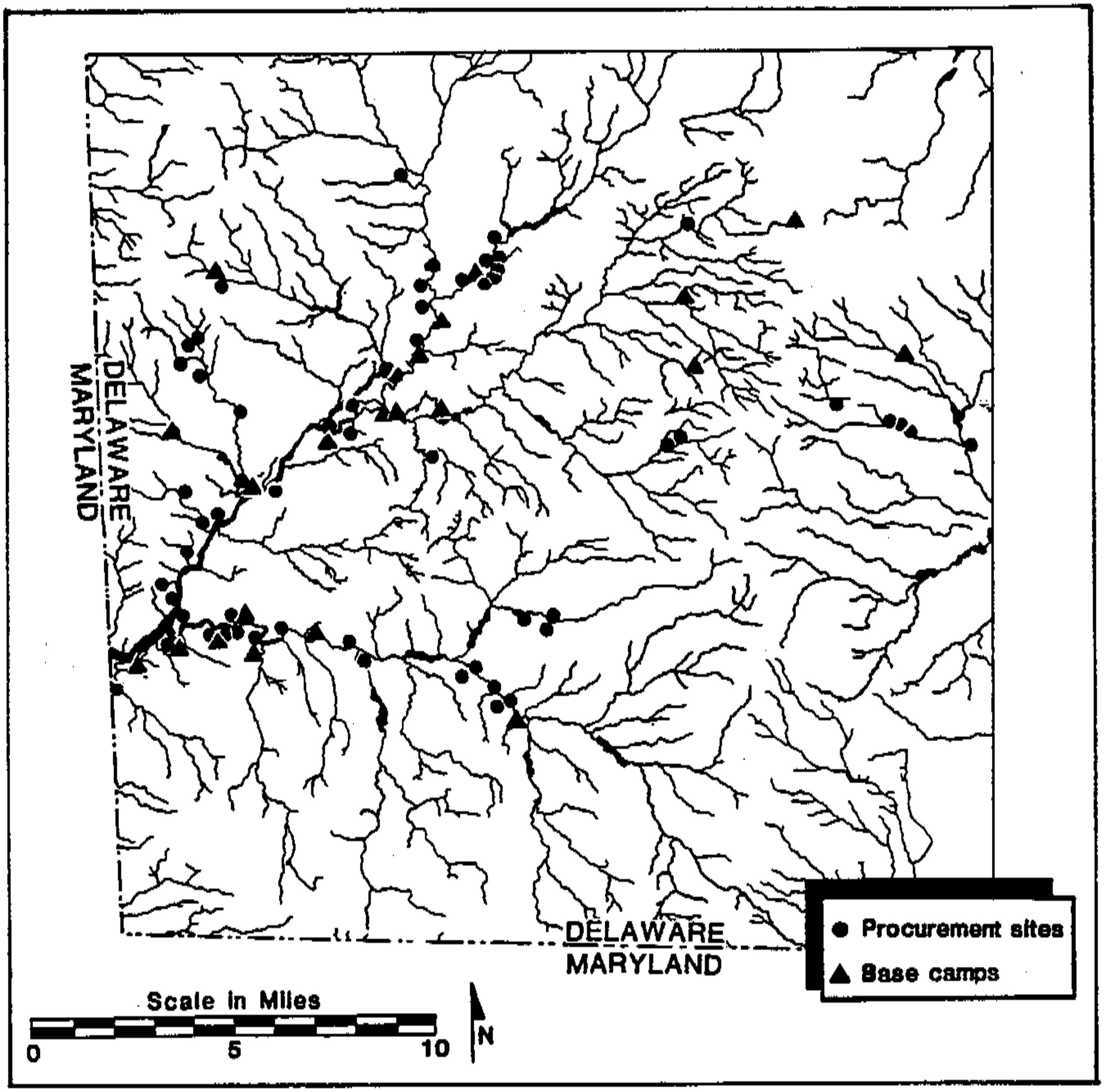
Clyde Farm Site Locations



Broad Creek, especially between Records Pond and the Nanticoke River. It may be that Clyde Farm settlement systems in this area involved a seasonal shift between base camps in riverine and drainage divide areas. However, this hypothesis needs to be tested with future

FIGURE 24

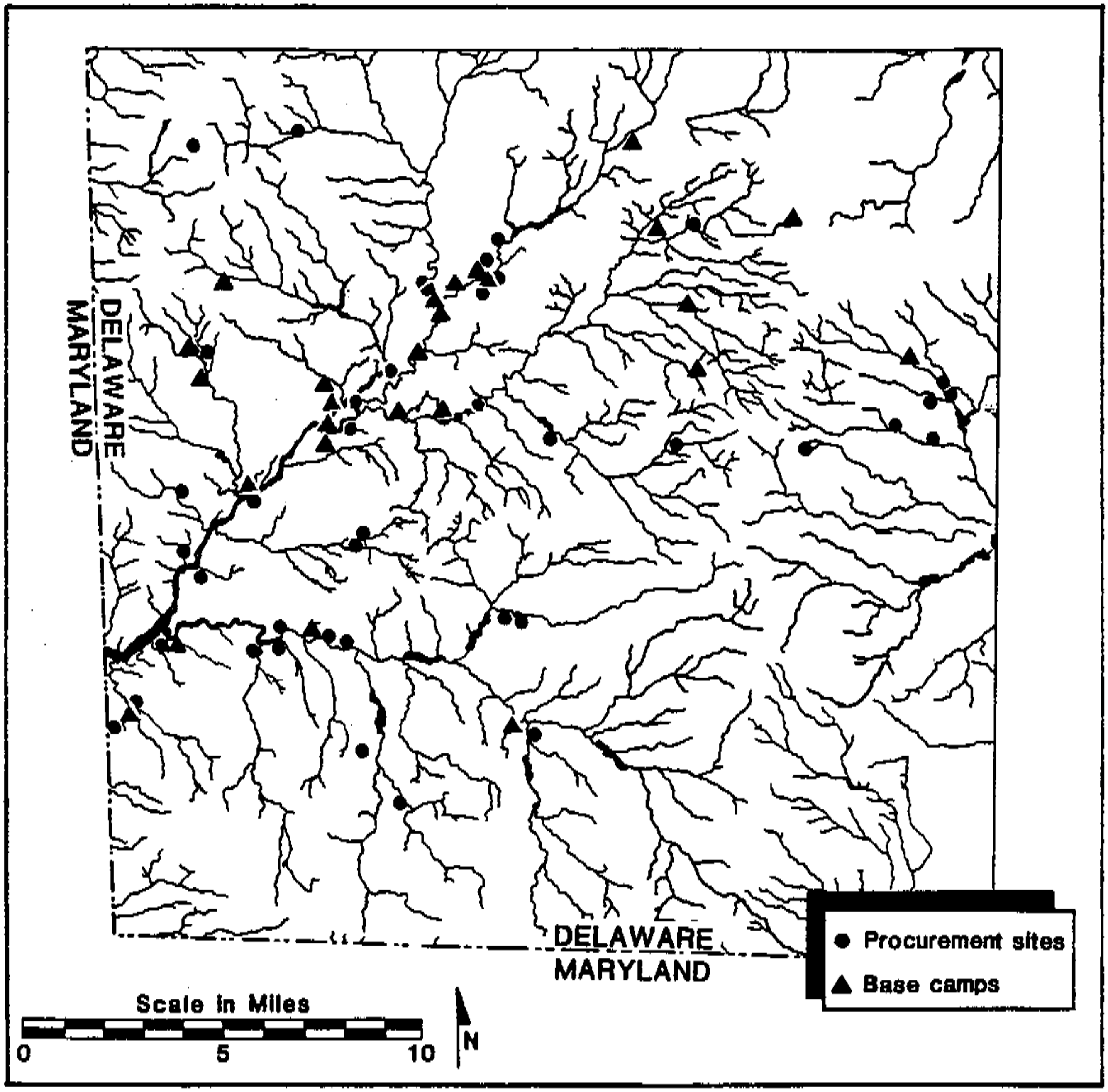
Wolfe Neck Site Locations



fieldwork. Some non-local lithic materials, including argillite, rhyolite, and steatite are present at these sites (Custer 1984c) indicating the existence of trade and exchange networks. However, the extent of non-local materials is not as great as that seen for

FIGURE 25

Carey Site Locations

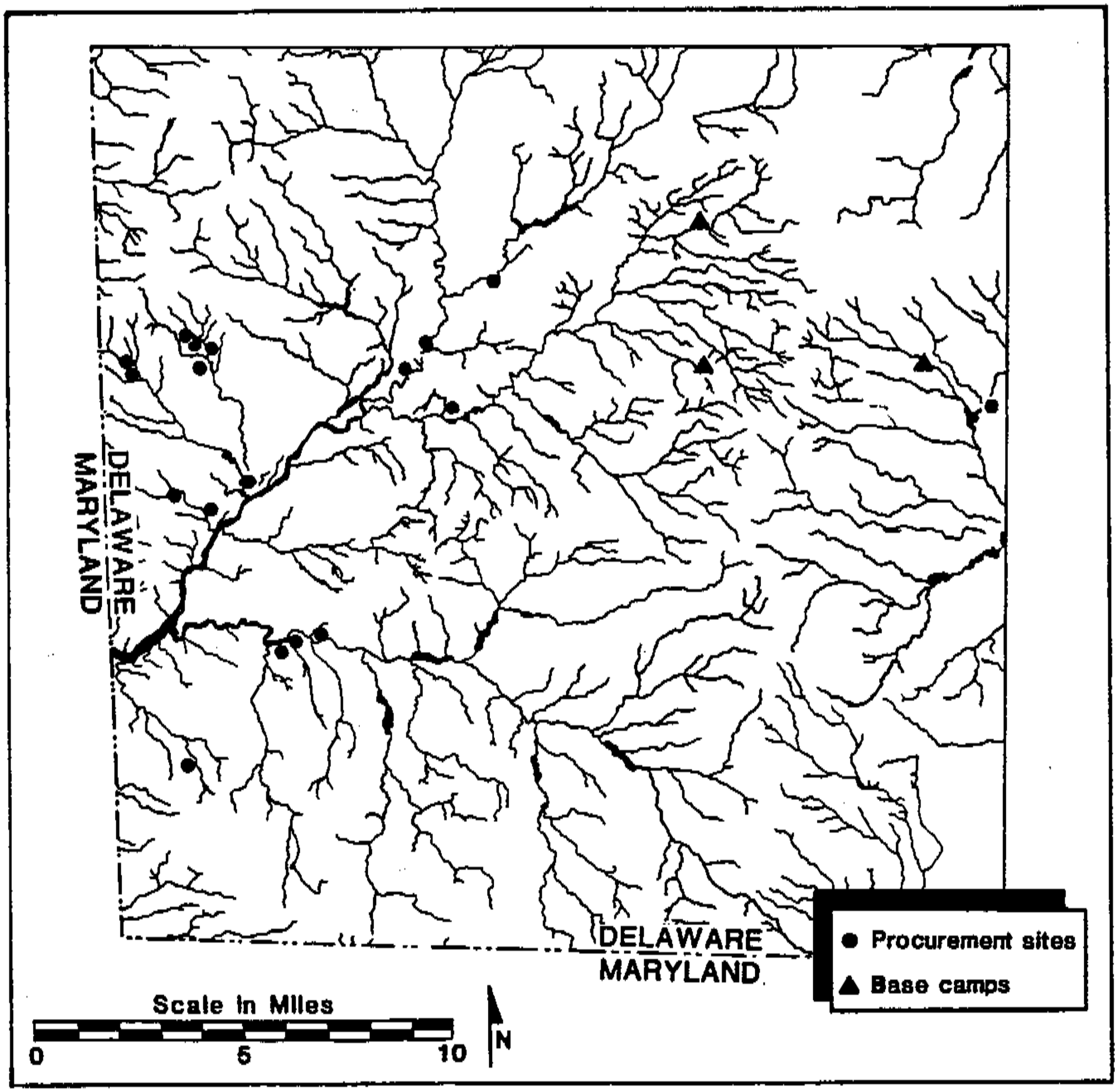


Barker's Landing Complex sites further to the north in Kent County.

Between 500 B.C. and 0 A.D., two roughly contemporaneous culture complexes, Wolfe Neck and Delmarva Adena are recognized for southern Delaware. The two complexes are generally thought

FIGURE 26

Late Carey Site Locations



to be mutually exclusive with Delmarva Adena Complex groups differentiated from Wolfe Neck groups by the presence of mortuary ceremonialism, non-local artifacts from Ohio, and more complex social systems (Custer 1984a:113). It is also known that the

Wolfe Neck complex slightly predates the Delmarva Adena complex (Custer 1984a:87; Griffith 1982). Whatever the relationship between the complexes, sites with occupations of both complexes are present to the west of the study area in the Atlantic Coast region (Custer 1987: Figures 23 and 24) where several individual sites have occupations by both complexes. It is also especially interesting to note that the Atlantic Coastal area includes one clear-cut example of a Delmarva Adena living site, the Wilgus Site - 7S-K-21 (Custer, Stiner, and Watson 1983). Given the presence of a living site, it is possible that complex mortuary sites may also be present in the Atlantic Coast area. In fact, one Delmarva Adena mortuary site, the Nassawango Site (Wise 1974), has been identified to the southwest of the study area on the Wicomico drainage in Worcester County, Maryland. In the Nanticoke study area, there are some occurrences of Delmarva Adena related ceramics (Coulbourn, Nassawango, and Wilgus), but there are few, if any, finds of clear-cut Adena mortuary artifacts. Therefore, all sites with Wolfe Neck or Coulbourn and related crushed clay tempered ceramics in the study area were placed in a single Wolfe Neck Complex (Figure 24). Further research on these sites may help to clarify the relationships between the societies of these two archaeological complexes.

Moving from Clyde Farm to Wolfe Neck Complex times (ca. 500 B.C.), the number of base camps increased dramatically in the riverine area (Figure 24). There is a definite shift from the use of lower Broad Creek as a procurement site area to a base camp area. This kind of shift and the dramatic increase in the number of base camp sites indicates increasing population densities in the riverine area. Similar settlement pattern trends are seen throughout the Delmarva Peninsula during Clyde Farm and Wolfe Neck times (Custer 1984a:94-130, 1988) and are thought to be related to environmental changes that occurred at this time (Custer 1984a:89-91). In general, these environmental changes exacerbated the well-watered/poorly-watered dichotomy of the environment and made riverine settings even more attractive than they were during earlier time periods.

With the onset of the Carey Complex (ca. A.D. 0), the basic settlement pattern of the Wolfe Neck Complex remained with little or no change in intensity (Figure 25). Presumably, population densities did not increase at this time. However, Carey Complex base camps tended to be located even further up the drainage than Wolfe Neck Complex base camps. Similar settlement shifts are noted for other Coastal Plain drainages (Custer 1984a:144) and are thought to be related to the upstream movement of the brackish/freshwater transition zone due to sea level rise.

By Late Carey Complex times (ca. A.D. 500 - 1000), there is a pronounced decrease in the number of sites in the Nanticoke drainage (Figure 26). It is possible that some of this decrease in settlement intensity is due to problems with identifying some ceramics from this time period. For example, the shell tempered refined-Mockley, or Claggett, ceramics (Custer 1984a:88-89) easily grade into earlier Mockley and late Townsend wares (Griffith 1982). However, there are other easily recognizable diagnostic artifacts from this time period such as Hell Island ceramics and Jacks Reef projectile points. Also, the reduction in numbers of sites is so dramatic that it is unlikely that it is exclusively an artifact of archaeological visibility. Therefore, there seems to be a real population reduction, or settlement disruption, in the Nanticoke drainage during terminal Woodland I times.

The Nanticoke population reduction and settlement disruption is not an isolated phenomenon and can be related to other regional events documented in the archaeological record of the central Middle Atlantic region. In Kent County, Delaware, there seems to be a fissioning of groups who inhabited large macroband base camps and an expansion of smaller microband base camps during Carey Complex times. This settlement pattern change has been linked to changes in social organizations and environmental circumscription (Custer 1982); however, the Carey Complex settlement shift in Kent County and the later population reduction in the Nanticoke area may be part of a single sequence of population disruption moving from north to south down the Delmarva Peninsula. Recent analyses of linguistic data (Feidel 1987; Luckenbach et al. 1987) suggest that migrations of various groups were taking place at this time and the terminal Woodland I population disruptions may be related to these migrations. Increased ceramic variability is also observed in the terminal Woodland I assemblages of this time period and may also be related to population reductions (Custer 1989). There is a definite north-to-south trend in the appearance of grit-tempered Hell Island wares (Custer 1984a:84). In southern Delaware, Hell Island wares appear to be a short-lived technological intrusion which appears with no immediate technological antecedents. Gleach's (1988) analysis of the Mockley ceramic chronology also notes a hiatus in Mockley dates coincident with such an intrusion. Furthermore, the potential appearance of northern Clemson Island ceramics and the newly-noted similarities of the Island Field site with Clemson Island sites (Custer and Rosenberg 1988) also suggest a north-south movement of populations during terminal Woodland I times. Although the data and interpretations are confusing at this time, it is clear that people were on the move during terminal Woodland I times and these population disruptions seem to be reflected in the Nanticoke area survey data, and in the Sussex East-West Corridor.

Figure 27 shows the general model of Woodland I site types and the possible groups movements among the site types. Typical locations of these site types for the riverine zone within the project area are noted in Figure 28. Table 10 lists the potential site location descriptions for both riverine and interior portions of the study area.

Woodland II sites of the study area (Figure 29) and adjacent areas of southwestern Delaware (Figure 30) are included within the Slaughter Creek Complex and the adaptations of the Slaughter Creek Complex have been subjected to intensive study (Thomas et al. 1975). Building from a careful analysis of the potential food sources found in the different environmental zones of southern Delaware, Thomas et al. (1975) developed a series of models of archaeological site distributions for the groups of people that would be exploiting these food resources. Two basic

FIGURE 27

General Woodland I Site Model

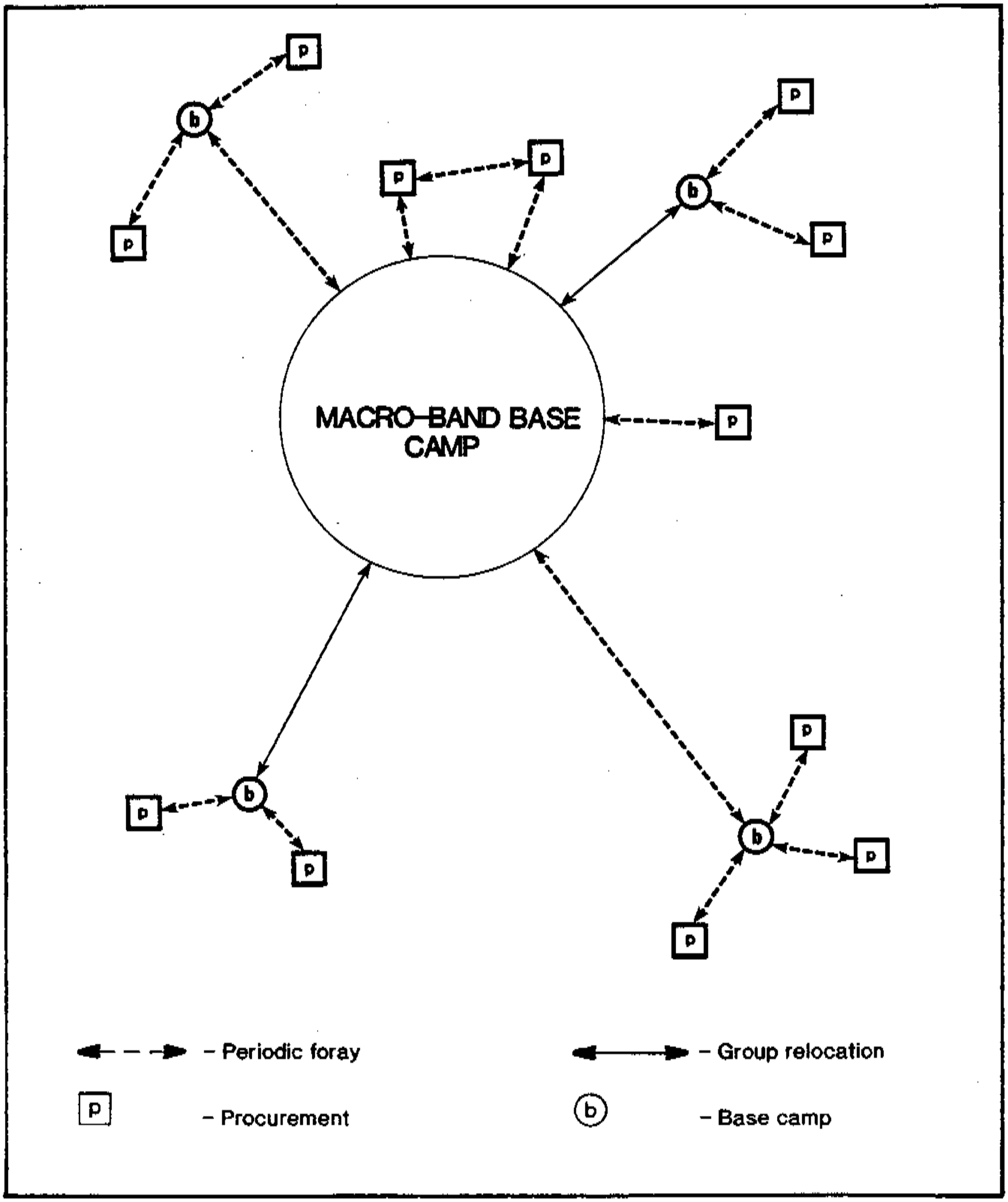


FIGURE 28

Woodland I Riverine Settlement Patterns

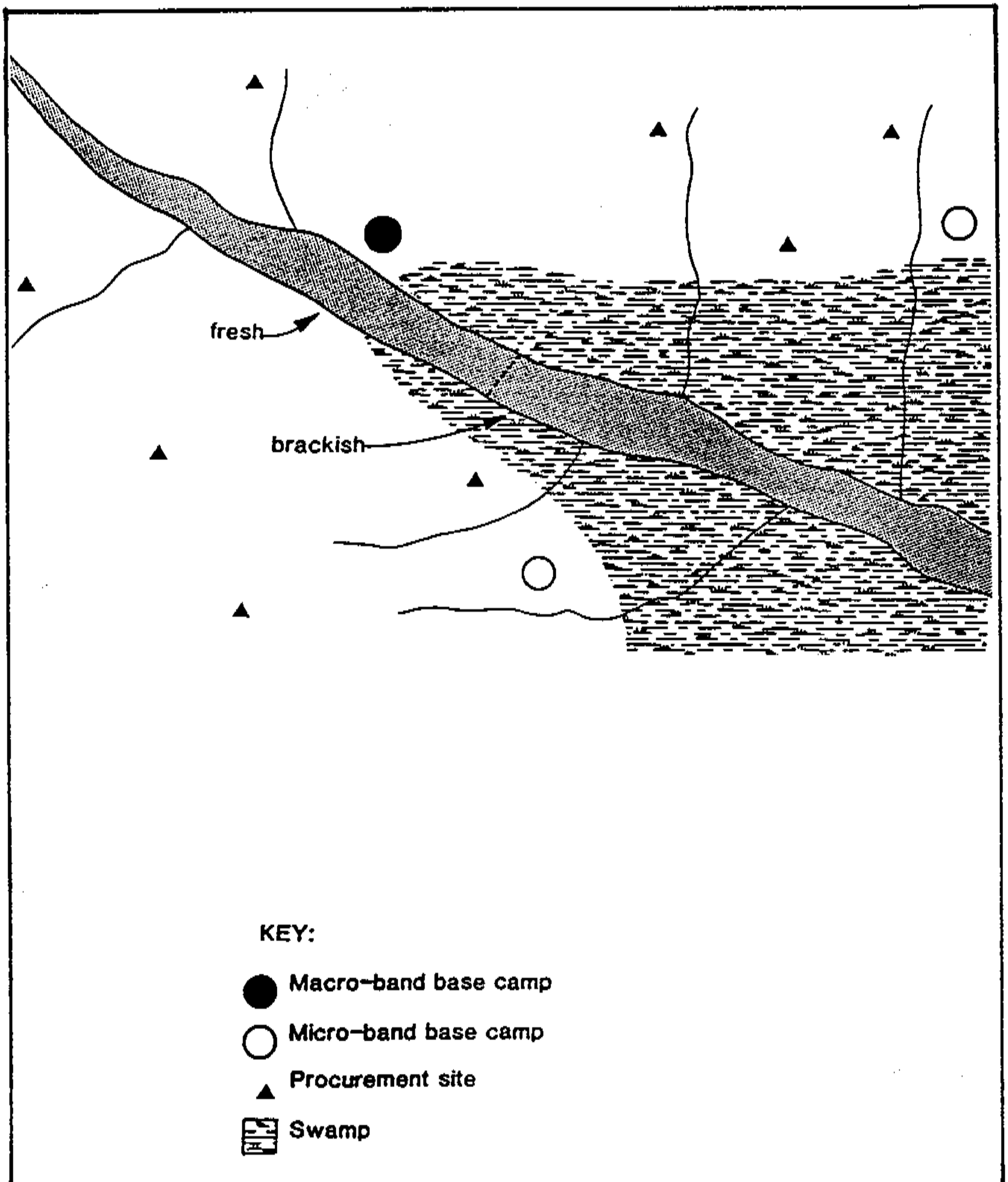
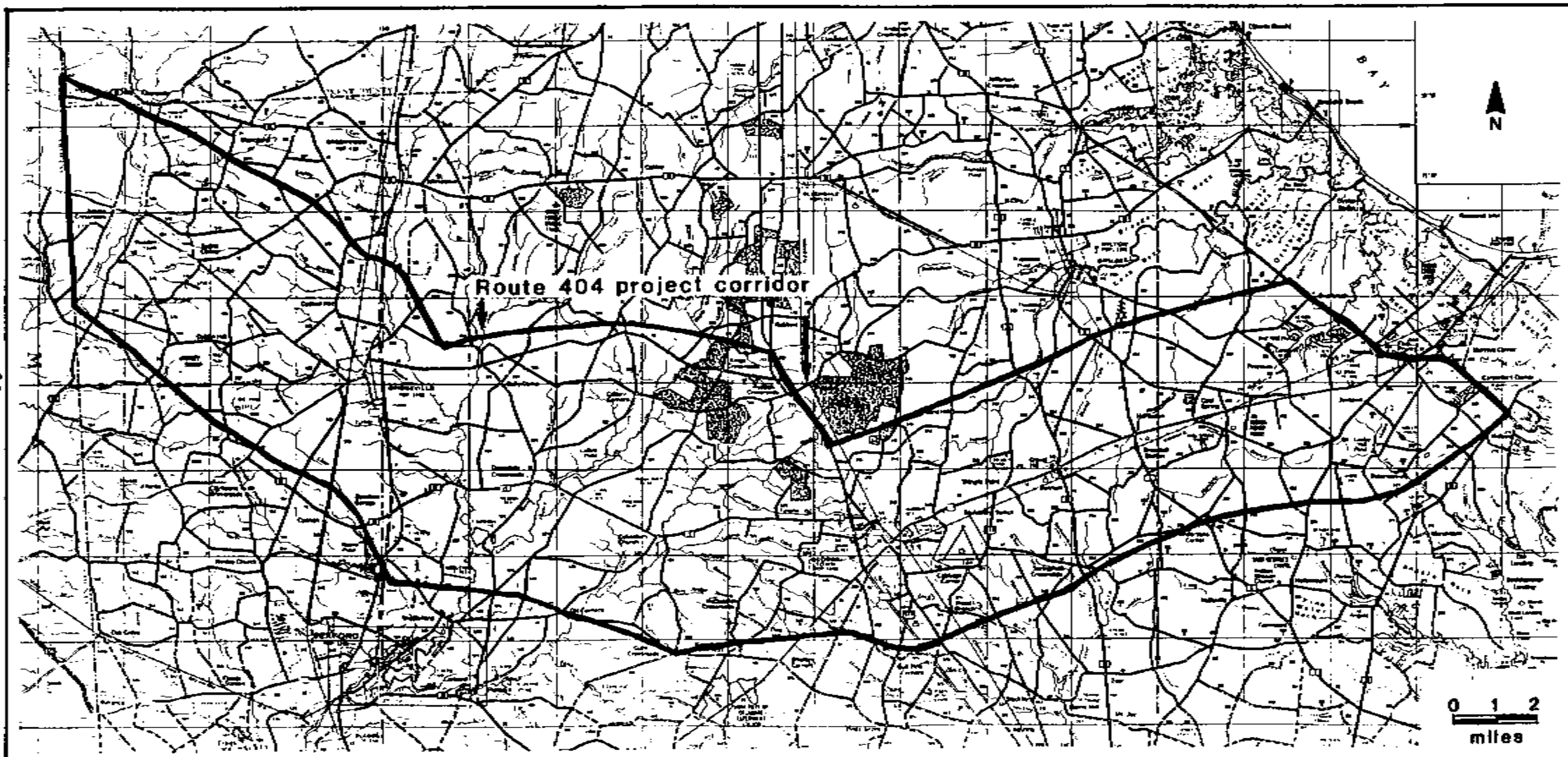


FIGURE 29

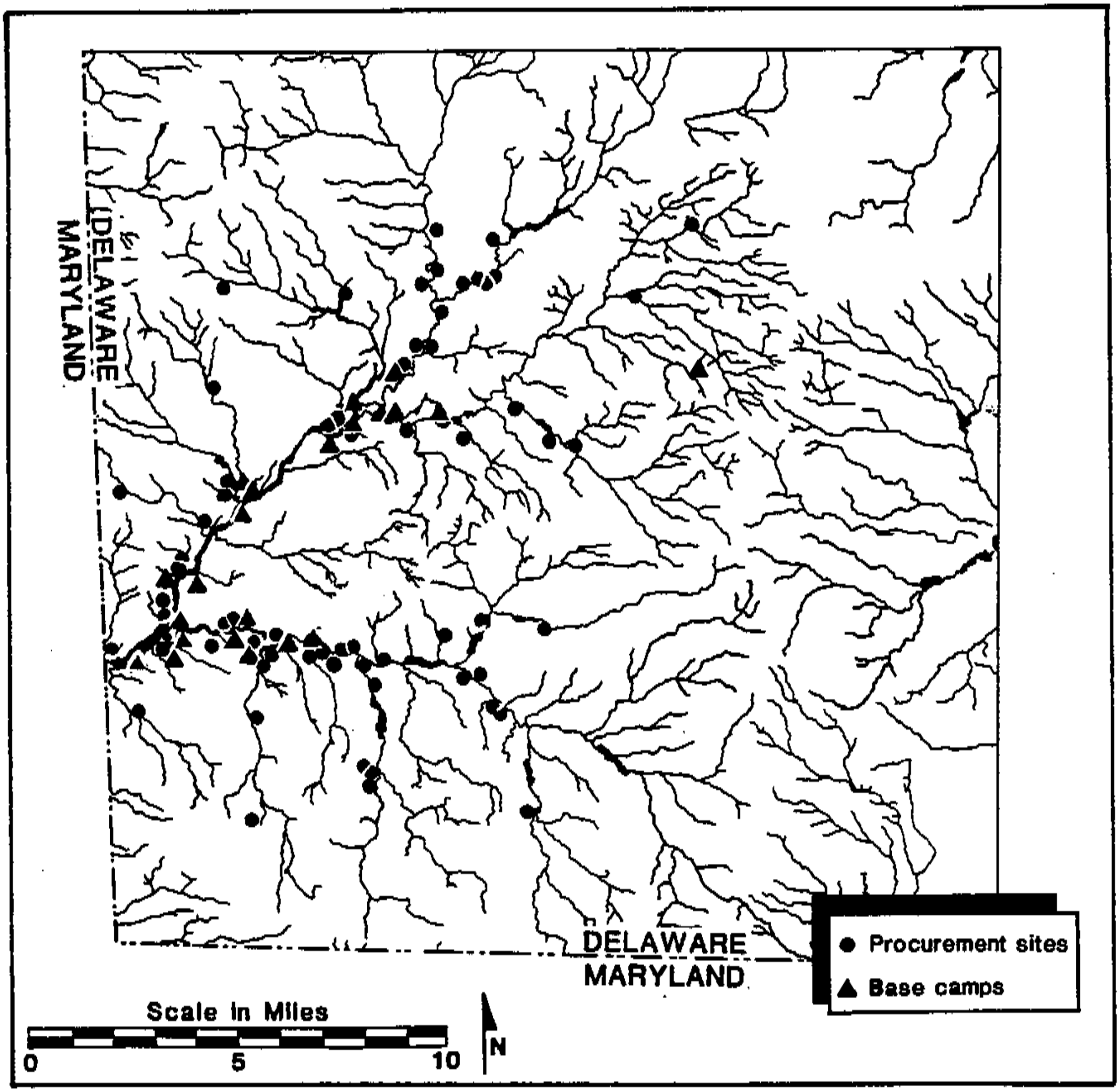
Woodland II Sites in the Study Area



* Site locations on file at DelDOT and U of D.

FIGURE 30

Woodland II Sites in Southwestern Delaware



site types were noted including seasonal camps and base camps (Thomas et al. 1975:62). Base camps would correspond to macro-band base camps and seasonal camps would correspond to micro-band base camps. No projections are made concerning individual

TABLE 10

WOODLAND I STUDY UNITS AND SITE LOCATIONS

Study Units	Data Quality	Site Types	Location
Riverine Zone	fair	macro-band base camp	low terraces of major drainages at stream confluences and at saltwater/fresh water interface of the marsh
		micro-band base camp	confluences of low order streams and tidal marshes
		procurement sites	along minor and ephemeral drainages adjacent to poorly drained woodlands and on small sand ridges and knolls
Interior Zone	poor	micro-band base camp	well-drained knolls at springs and stream confluences
		procurement sites	well-drained knolls at swamps and springs

procurement sites. Five basic models of the settlement patterns were generated from the analyses of potential food sources and each model projected different combinations of micro-band base camps in different environments during different seasons (Table 11). Each settlement model assumes a different degree of residential stability ranging from groups of transient micro-band base camps to single sedentary macro-band base camps of villages. After models were developed, the expected artifact distributions were noted.

Because there are few excavated sites in the Nanticoke drainage, it is difficult to say which of the models noted in

TABLE 11

SLAUGHTER CREEK COMPLEX SETTLEMENT MODELS
(Thomas et al. 1975:60-65)

Model	Winter	Spring	Summer	Fall
1	micro-band base camp; interior	micro-band base camp; mid-drainage	micro-band base camp; coastal	micro-band base camp; mid-drainage
2 ->	macro-band base camp; interior	micro-band base camp; mid-drainage	macro-band base camp; coastal	macro-band base camp;-> interior
3	macro-band base camp; interior	macro-band base camp; coastal	-------------->	macro-band base camp; interior
4 ->	macro-band base camp; mid-drainage	-------------->	micro-band base camp; coastal	macro-band base camp;-> mid-drainage
5 ->	macro-band base camp; mid-drainage	-->		

Table 11 is the most accurate. It can be noted that by Woodland II times (A.D. 1000 - 1600), settlement intensity and population levels returned to levels comparable to those of the Woodland I period after their reduction during Late Carey Complex times. If anything, the settlement focus on the main stem of the Nanticoke and its major tributaries was even greater during Woodland II times. Temperature and moisture perturbations noted in the paleoenvironmental record for late prehistoric times (Brush 1986; Custer and Watson 1987) may be related to the settlement focus on the higher order streams. If the Woodland II sites from the lower Marshyhope (Flegel 1975a, 1975b, 1976, 1978; Callaway, Hutchinson, and Marine 1960; Corkran and Flegel 1953; Hutchinson, Callaway, and Bryant 1964; McNamara 1985) are considered, it can be noted that most of the sites seem to be microband base camps.

Therefore, Models III and IV (see Table 11) are probably the most accurate (Figures 31 and 32). These models have a moderate degree of residential stability and intensification of food production, use of storage, and group size could be maintained at low levels comparable to those seen in Woodland I times. Continuity in settlement patterns from Woodland I into Woodland II times seems to be present.

Because of the continuity in settlement patterns and basic adaptations between Woodland I and Woodland II times, the study units listed for the Woodland I Period (Table 10) would also apply to the Woodland II Period.

No Contact Period sites are known from the study area. Because the major effect of European Contact was the reduction of the local populations, the settlement patterns and site distributions of the Woodland II Period would apply, but their numbers would decrease. Data quality for all areas would be poor and site frequencies would decrease through time.

The models noted above provide a general guide to the types of locations where various types of prehistoric archaeological sites are likely to occur. However, the form in which they are presented above is not sufficient by itself for assessing the archaeological potential of a specific area, such as various portions of the project area. It is necessary to carry out additional analysis of the terrain of a given area and then compare the results of the analysis with the environmental settings depicted, or described in the models. Based on observed similarities, or differences, the archaeological potential of the

FIGURE 31

Woodland II Settlement Model III – Slaughter Creek Complex

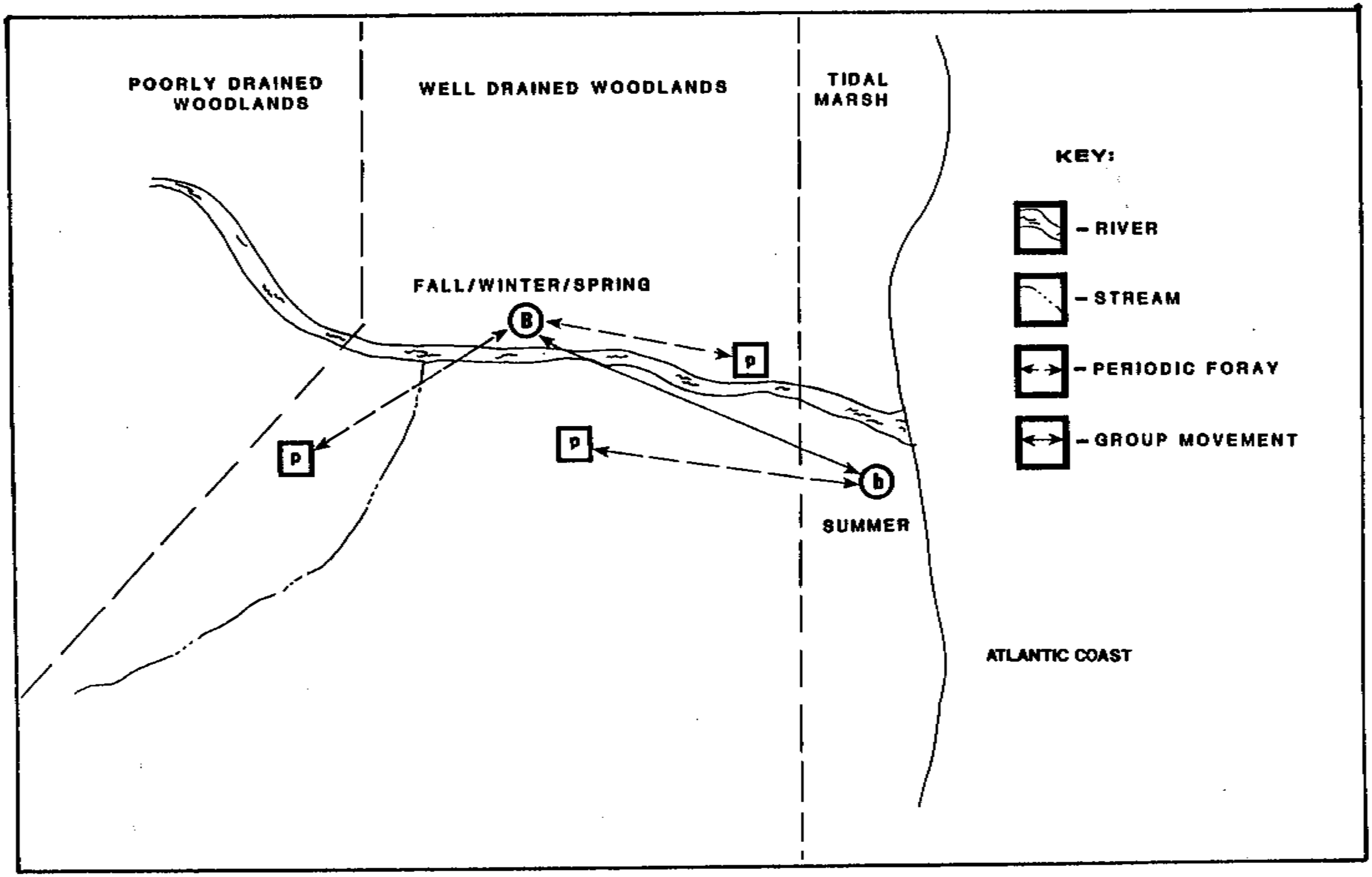
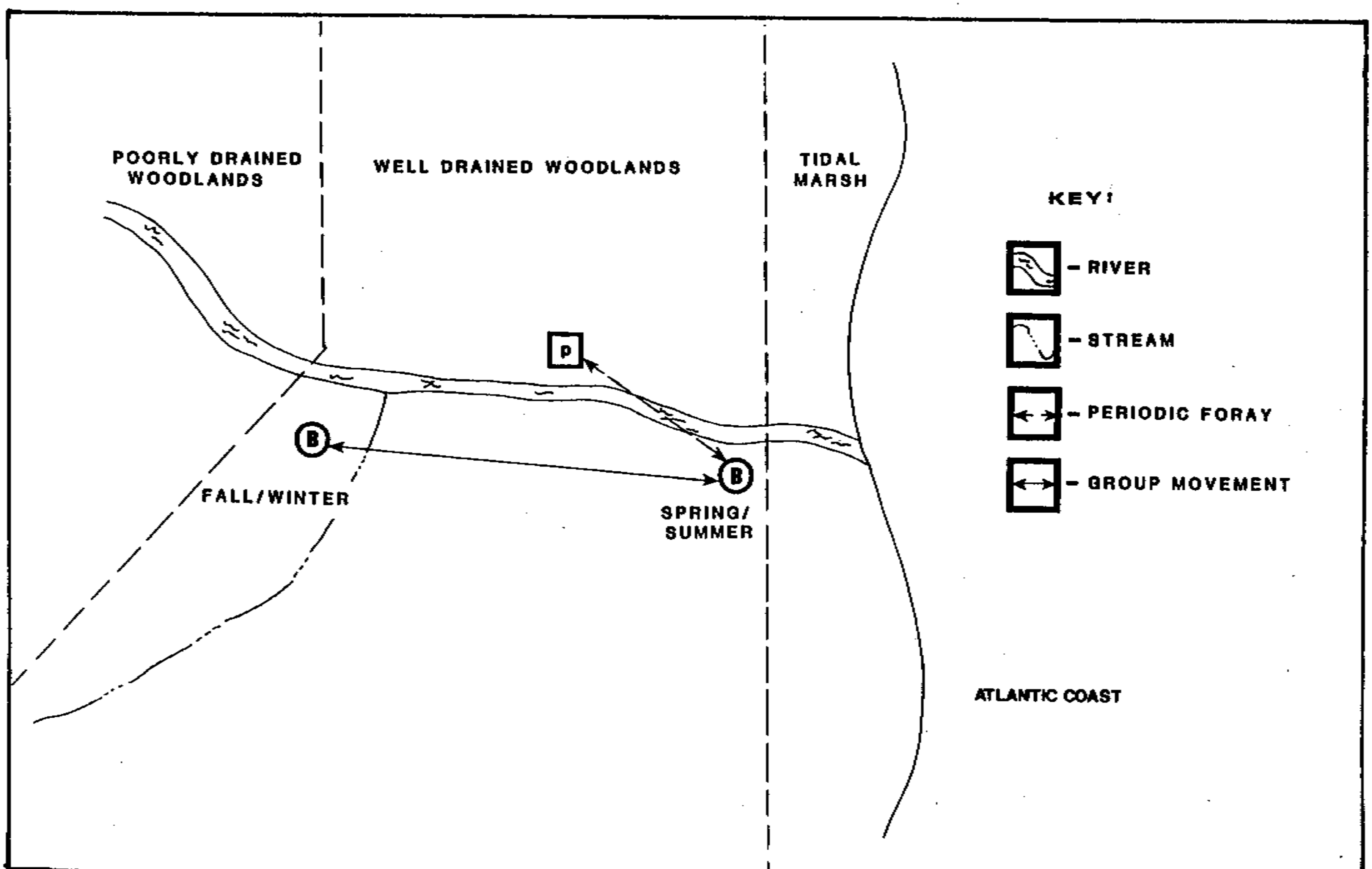


FIGURE 32

Woodland II Settlement Model IV – Slaughter Creek Complex



area in question can be assessed. In most cases, the terrain analysis is carried out in a rather impressionistic way with no quantification of the degree of similarity between the ideal model and the actual terrain. However, newer techniques involving quantitative analysis have been developed by the Center for Archaeological Research and the Center for Remote Sensing of the University of Delaware. These techniques are described below and the description is taken from Custer, Jehle, Klatka, and Eveleigh (1984); Custer, Eveleigh, Klemas, and Wells (1986); and Eveleigh et al. (1983). It should also be noted that the model described below is directly derived from the more impressionistic models noted above.

The research by the University of Delaware has been oriented specifically towards the use of environmental data generated by the LANDSAT satellite. The LANDSAT satellite passes over the Delmarva Peninsula every eighteen days at an altitude of 920 km (Klemas 1977:387) and records four wave lengths of light using a multispectral scanner and a return beam vidicon. The data are recorded and transmitted in digital form and analysis is carried out using digital data. LANDSAT data can be used to classify and map various types of environmental zones by first identifying special categories of land classes on the ground. These areas called training sets can then be identified on the LANDSAT image and the special spectral characteristics of that area can be determined using a variety of statistical techniques (Klemas 1977). Once the special spectral characteristics have been identified, other elements of the LANDSAT image, called pixels, can be compared to the original training set and classified accordingly. Mapping of environmental zones using LANDSAT is quite accurate and comparative studies of remote sensing methods and ground truth data indicate that LANDSAT data produces accurate classifications 87% of the time in coastal environmental settings (Klemas 1977:387). Also, the resolution of the mapping is approximately 80 meters which can discriminate among closely spaced environmental zones. Probably the most important feature of LANDSAT mapping of environmental zones, however, is the fact that it can allow the mapping of large areas very quickly and inexpensively.

Several researchers have attempted to apply LANDSAT data to archaeological studies. In most cases LANDSAT data have been used to map out varied environmental zones that can be correlated in a general way with archaeological site distributions (Hamlin 1977; Schalk and Lyons 1976). However, none of these studies has been able to generate specific maps of zones likely to contain archaeological sites. The major difficulty in applying LANDSAT data has been that most archaeologists who work with remote sensing techniques have attempted to look for specific on-the-ground features, such as crop marks, shell scatters, or architectural features, to locate archaeological sites (Ebert and Lyons 1976). Because resolution of the LANDSAT data is 80m it is generally unsuitable for the specific remote sensing of archaeological sites, although it should be noted that Quann and Bevan (1977) were able to recognize the shadow of the pyramids at Giza. Nevertheless, given the non-spectacular nature of the archaeological remains in the Middle Atlantic region, specific sensing of archaeological sites using LANDSAT is unlikely to succeed in all but a very few cases.

The work of Ian Wells (1981; Wells et al. 1981) provides an alternative approach to the application of LANDSAT data to archaeological modeling. Wells' work did not use LANDSAT data directly to generate an archaeological predictive model; however, he did use a geographic information system (GIS) that was similar to those that can be generated from LANDSAT. Rather than look for specific variables that could be correlated with archaeological sites locations, Wells considered combinations of environmental variables derived from the general models noted above that could be quantitatively correlated with known locations of archaeological sites such as distance to surface water of varying orders, distance to interfaces of well-drained and poorly drained soils, and the presence of special topographic features such as sinkholes, bay/basin features, or river levees (Wells 1981:41-46). This kind of snyoptic analysis is different from specific analysis in that it considers regional combinations of variables relevant to archaeological site locations rather than indications of specific site locations. As such, it was able to take advantage of the best features of the LANDSAT data.

Wells used a statistical technique known as a logistical regression (Chung 1978) to analyze the relationship between locations of known archaeological sites, as well as locations known not to contain archaeological sites, and environmental variables. Although other statistical methods have been successfully used in similar analyses (eg., Kvamme 1981), the logistical regression model was used because it can be applied to gridded data bases, there are few restrictions on the distributions of independent variables, the dependent variable always lies between 0 and 1, and the algorithm is robust and can produce results even from noisy data (Wells 1981:23). The form of the logistic model, which estimates the probability that a certain cell contains at least one site is (Wells 1981:24):

$$PROB(Y(i)=1) = E(Y(i)) = \frac{e^{X(i)'b}}{1+e^{E(i)'b}}$$

where

$$X(i)' = (1, X_{i1}, X_{12}, \ldots X_{ip}$$

is a vector of the p predictor variables at grid cell i and

$$b = (b_0, b_1, \ldots b_p$$

is a vector of regression coefficients to be estimated. Y(i) is the independent variable between 0 and 1. The input to the logistical regression model consists of the Y(i) of known test sites (i.e., the probability value of 1 for locations known to contain archaeological sites and the probability value of 0 for locations known not to contain archaeological sites) and X(i), the observational values of the environmental variables.

A series of computer programs, called the ODESSA system, was developed by Wells to apply the logistical regression to an archaeological predictive problem. Simply stated, the ODESSA model first derived a logistical regression equation using the results of an archaeological survey of a section of the north bank of the Appoquinimink River in southern New Castle

County (Gardner and Stewart 1978) as a training set. The environmental variables utilized were: distance to closest minor stream, distance to major steam or river (recognized in the data base as a dammed lake or reservoir), distance to openland rated (well-drained) soil, local gradient, convexity of the landscape, and distance to present marsh (Wells 1981:41-46). All of these variables were recorded for the study area in a 500' grid cell data base AERIS system developed for planning purposes in New Castle County. The ODESSA equations derived from the training set were in a sense a linear series of coefficients such that if the observed distances and variables were multiplied by the distance and observations for the variables, a location known to contain a prehistoric archaeological site would generate a value for the equation of 1. Similarly, a location known not to contain a site would generate a value of 0. Using an analysis of variance, the equations developed by Wells accounted for 72% of the variation of site locations in the training set (Wells 1981:41).

After the equations were developed, the ODESSA system was applied to an area that previously had not been archaeologically surveyed. The environmental variables for each cell were input to the previously developed equation and each cell's variables produced a value between 0 and 1. This value is the probability that the unsurveyed cell will contain an archaeological site. Wells produced a map of the cells likely to contain sites (p. 1) and field checks showed the predictions to be quite accurate (Wells 1981:49-54). In sum, Wells' use of the ODESSA model provides a way in which data similar to that gathered by LANDSAT can be quantitatively linked to archaeological site locations on a synoptic basis. Most importantly, the ODESSA model produced probability maps for archaeological site locations. However, the ODESSA system did not use LANDSAT data and it was somewhat limited in its applicability in that it used an area of relatively limited environmental diversity (a floodplain and adjacent headlands) as a training set.

A more recent study of the Kent County area (Eveleigh et al. 1983; Custer, Eveleigh, Klemas, and Wells 1986) took the ODESSA model, with its use of the logistical regression analysis, and directly applied it to a new training set from the Kent County area that included a GIS of environmental variables developed directly from LANDSAT. A sample of site areas from the St. Jones/Murderkill drainage area was chosen as a training set because it was a controlled, stratified, random sample of a variety of environmental settings. Also, the Kent County area's general environmental structure was similar to the Appoquinimink area studied by Wells. Finally, the time range of the majority of sites discovered in both the Appoquinimink and St. Jones/ Murderkill area was the same (ca. 3000 B.C. - A.D. 1000).

The first step in the Kent County study was to classify the LANDSAT image into culturally relevant environmental zones. Classification of the LANDSAT image was accomplished using computer programs of the Earth Resources Data Analysis System (ERDAS). In these programs the operator interactively picks a series of LANDSAT sensing units (pixels) that seem to have similar spectral characteristics and which seem to match with culturally significant (Chenhall 1975) environmental variables. The programs report on the spectral characteristics and purity of the series by displaying histograms of pixel brightness and a series of statistical indicators. As accurate and useful classifications are obtained, they are saved in a signature catalogue file. This type of classification is termed a supervised classification (Klemas 1977:389) and 16 specified signatures were generated for the Kent County area. These signatures and their spatial distribution were then compared to infrared aerial photographs, color aerial photographs, and USGS topographic maps to insure their utility. Table 12 lists the variables that were utilized in the final classified scene. The classified scene was then converted to a 50m GIS by the ERDAS system.

The data base generated by the program contained a number of variables including percentages of ground truth grid cells that were classified into the variables listed in Table 12, and a series of minimum distance measures (converted to log distances) to a series of critical environmental variables (Table 12) similar to those shown to be important by Wells (1981:41-46). These variables formed the data base that was utilized in the ODESSA logistical regression model. The regression model was initially run using the variables listed in Table 12 and converged on a solution. The fact that the model converges on a solution implies that the variables selected do have some meaning for predicting locations.

After the model had converged on a solution, the sections of the study area that had not been included as part of the 5%

TABLE 12

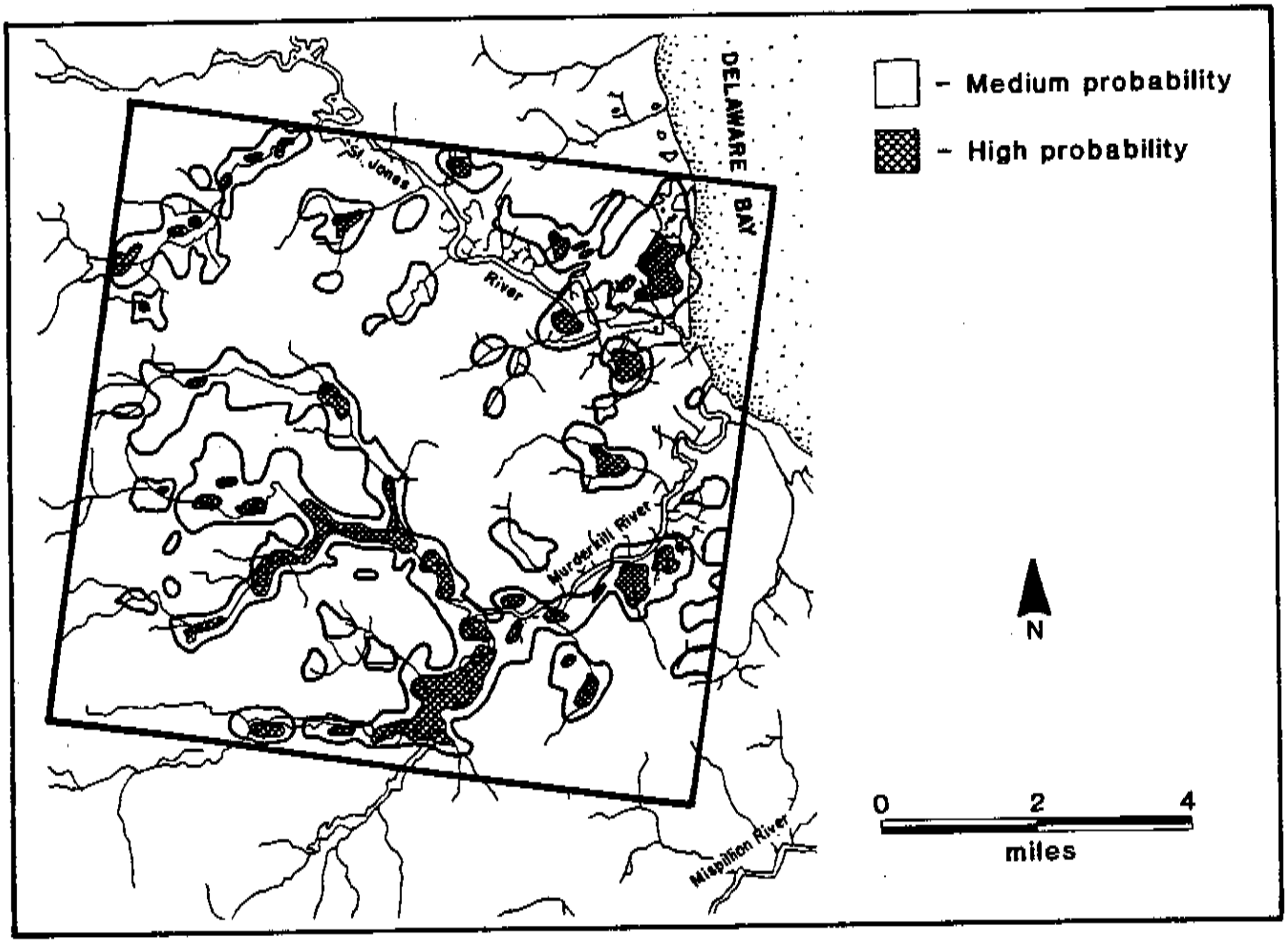
VARIABLES USED IN LANDSAT CLASSIFICATION

Variable Label	**Ground Description**	**Edaphic Factor**
Deep Water	Bay and deeper parts of rivers	High order streams
Shallow, Turbid Water	Turbid sections of rivers	Moderate order streams
Shallow, Clear Water	Less turbid sections of rivers	Low order streams
Salt Marsh 1	Tidal wetland with low productivity	High salinity marshes
Salt Marsh 2	Tidal wetland with high productivity	Brackish and low salinity marshes
Trees	Wooded areas	Very poorly drained soils
Agricultural 1	High productivity farm land	Well-drained soils with some moisture retention
Agricultural 2	Low productivity farm land	Well-drained soils with little moisture retention
Bare Soil 1	Bare soils, dead grasses	Moderately drained soils
Bare Soil 2	Bare soil, dead grasses	Moderately drained soils

stratified, random sample were run through the regression equation and the probabilities for each cell were noted. Contour maps of the site probabilities (Figure 33) were developed and used as part of the original Route 13 Planning Study (Custer, Jehle, Klatka, and Eveleigh 1984).

FIGURE 33

St. Jones/Murderkill Probability Map



The predictive model has been subjected to several tests since its initial application to the Route 13 Project. Two planning studies of the Route 13 Corridor (Custer, Bachman, and Grettler 1986; Custer and Bachman 1986a), the Phase I survey of the final Route 13 Early Action Segment (Bachman, Grettler, and Custer 1988), a survey of the Murderkill drainage specifically focused on testing the LANDSAT predictive model (Gelburd 1988), and the test data generated from the original St.

Jones/Murderkill survey (Eveleigh, Custer, and Klemas 1983) all specifically tested the predictions of the LANDSAT model. Table 13 summarizes the test results from these studies and in all cases there are no significant differences between the model's expected results and the observed results of the surveys. Therefore, the accuracy of the model's predictions has been verified by field testing on several occasions.

Application of the LANDSAT predictive model to the Sussex East-West Corridor (Route 404) followed a similarapproach to that used in the Route 13 project. The model was thought to be applicable to the Sussex East-West Corridor project area because the environmental settings of the Sussex East-West Corridor and Route 13 projects are very similar. Both are located in the Low Coastal Plain and have fairly extensive freshwater and brackish wetlands. Furthermore, soils in both areas are quite similar. Because of the environmental similarities between the two areas, the LANDSAT image of the Sussex East-West Corridor was classified into the same environmental zones used in the Route 13 Project (Table 12).

The Route 13 model used five main variables, all of which were related to the presence of surface water and wetlands of various types. A factor analysis of the environmental variables used in the model for the St. Jones/Murderkill area also shows that the main variables used in the logistical regression are highly inter-correlated (Table 14) and are measures of surface water and wetlands. As, as an experiment, a series of predictive maps were developed using only distance to the water measures as a predictor for archaeological site locations.

TABLE 13

DELAWARE LANDSAT PREDICTIVE MODEL TEST RESULTS

Route 13 Phase I Survey (Bachman, Custer, and Grettler 1988)

Probability Zone	Total # of Quadrats	Expected # With Sites	Observed # With Sites
H	8	7	1
M	25	15	4
L	223	22	19

Chi-square = 2.88, .25<p<.50

Murderkill Drainage Survey (Gelburd 1988)

Probability Zone	Total # of Quadrats	Expected # With Sites	Observed # With Sites
H	4	4	4
M	17	11	15
L	56	14	10

Chi-square = 1.53, .1<p<.25

Route 13 Planning Study, Kent County (Custer, Bachman, and Grettler (1986)

Probability Zone	Total # of Quadrats	Expected # With Sites	Observed # With Sites
H	36	32	28
M	110	69	74
L	96	24	23

Chi-square = .9, .25<p<.50

Route 13 Planning Study, New Castle County (Custer and Bachman 1986)

Probability Zone	Total # of Quadrats	Expected # With Sites	Observed # With Sites
H	19	17	17
M	37	23	27
L	19	5	7

Chi-square = 1.16, .25<p<.50

St. Jones/Murderkill Test Data (Eveleigh, Custer, Klemas 1983)

Probability Zone	Total # of Quadrats	Expected # With Sites	Observed # With Sites
H	47	41	45
M	34	21	29

Chi-square = 3.44, .10<p<.25

TABLE 14

FACTOR CORRELATION MATRIX - ENVIRONMENTAL VARIABLES

Environmental Variable	Factor 1	Factor 2	Factor 3
Shallow, Clear Water	.167	.693*	-.090
Salt Marsh 2	.090	.595*	.068
Salt Marsh 1	.387	.454*	-.032
Trees	.199	.363*	.346
Shallow, Turbid Water	-.246	.697*	-.109
Agricultural 1	-.165	-.063	.505
Agricultural 2	.195	-.093	.517
Bare Soil 1	.633	-.096	-.168
Bare Soil 2	.571	.033	.029
Deep Water	-.323	.011	-.399

* Inter-correlated variables

These distance-derived maps are essentially identical to the predictive maps generated by the application of the logistical regression model. A distance-based approach was used to develop predictive maps for the main section of the Nanticoke (Custer 1989) and preliminary tests of the model's results (Table 15) shows it to be as accurate as the models derived from the application of the logistic regression.

Updates in equipment and software for satellite remote sensing at the University of Delaware since 1984 required revisions in the procedure developed by Eveliegh (1984). Customized FORTRAN programs (Kellogg 1990) were written to duplicate the logistic regression model on the new facilities. The revised programs reproduced the results of Eveleigh (1984)

TABLE 15

COMPARISON OF PREDICTIVE MODEL AND SURVEY RESULTS FOR THE NANTICOKE DRAINAGE

	Probability Zones		
	High	**Medium**	**Low**
Expected	147	71	15
Observed	146	68	20
	Chi-square=1.39	D.O.F.=.2	p>.50

Source: Custer and Mellin 1989

and Custer et al. (1986) for the St. Jones/Murderkill region using the same data.

One modification was introduced into the production of predictive maps. Instead of calculating probabilities for large grid squares and then contouring the data as in Eveleigh (1984), predictive values were calculated for each pixel of the LANDSAT image. Thus a probability was determined for every 50m square of the study area based on the logistic regression results. A plotter output at a scale of one inch per mile was transfered to the 7.5' quadrangle maps of Attachment II. Probability values were grouped as follows: high probability zones have site-occurrence probability values greater than 0.70, medium probability zones have site-occurrence probability values between 0.50 and 0.70, and low probability zones have site-occurrence probability values less than 0.50. It should be noted that the low probability zone is not devoid of sites. Sites may still be present, but they will be present in significantly lower frequencies compared to the medium and high probability zones.

It can also be noted that the high probability zones will contain most of the base camp sites that have the greatest potential for being sufficiently significant to warrant nomination to the National Register of Historic Places. The medium probability zone contains mainly micro-band base camps which are also likely to be eligible for the National Register, but are smaller, and less expensive to study, than the sites in the high probability zones. The low probability zone contains mainly procurement sites which are much less significant, unlikely to be intact, and not likely candidates for the National Register. Even if they are deemed significant enough for listing on the register, they are the least expensive to mitigate. Thus, the probability zones shown in Attachment VI are a guide to general locations of classes of sites of varying significance. Further discussion of management considerations is provided in the final section of this report. The zones mapped in Attachment VI can also be combined with the diagrams of typical site locations (Figures 18-21, 31, and 32) and lists of descriptions of typical locations (Figures 22-26, 29, and 30) to note specific individual site locations within the study area.

HISTORIC SITES

The predictive models utilized for historic settlement patterns within the project corridor were developed from the inventories of standing structures at the BAHP, which are listed in Appendix II, from the comprehensive historic state plan developed by Ames et al. (1987) and Herman and Siders (1986), and from the data concerning historic archaeological sites obtained from historic atlases, road papers, and other historic sources, shown in Appendix III. According to Ames et al. (1987:38), Sussex County in general, and the project corridor in particular, offers a unique opportunity to examine cultural resources which evolved in a relatively stable demographic context. Settlement patterns within the County were reinforced instead of replaced, and newer development was integrated with the old, creating an historic landscape in which the changes over time are still evident (Ames et al. 1987:37). The integration and slow replacement of historic settlement patterns suggests that many historic sites are present within the project corridor as archaeological sites, dating from all time periods across the corridor.

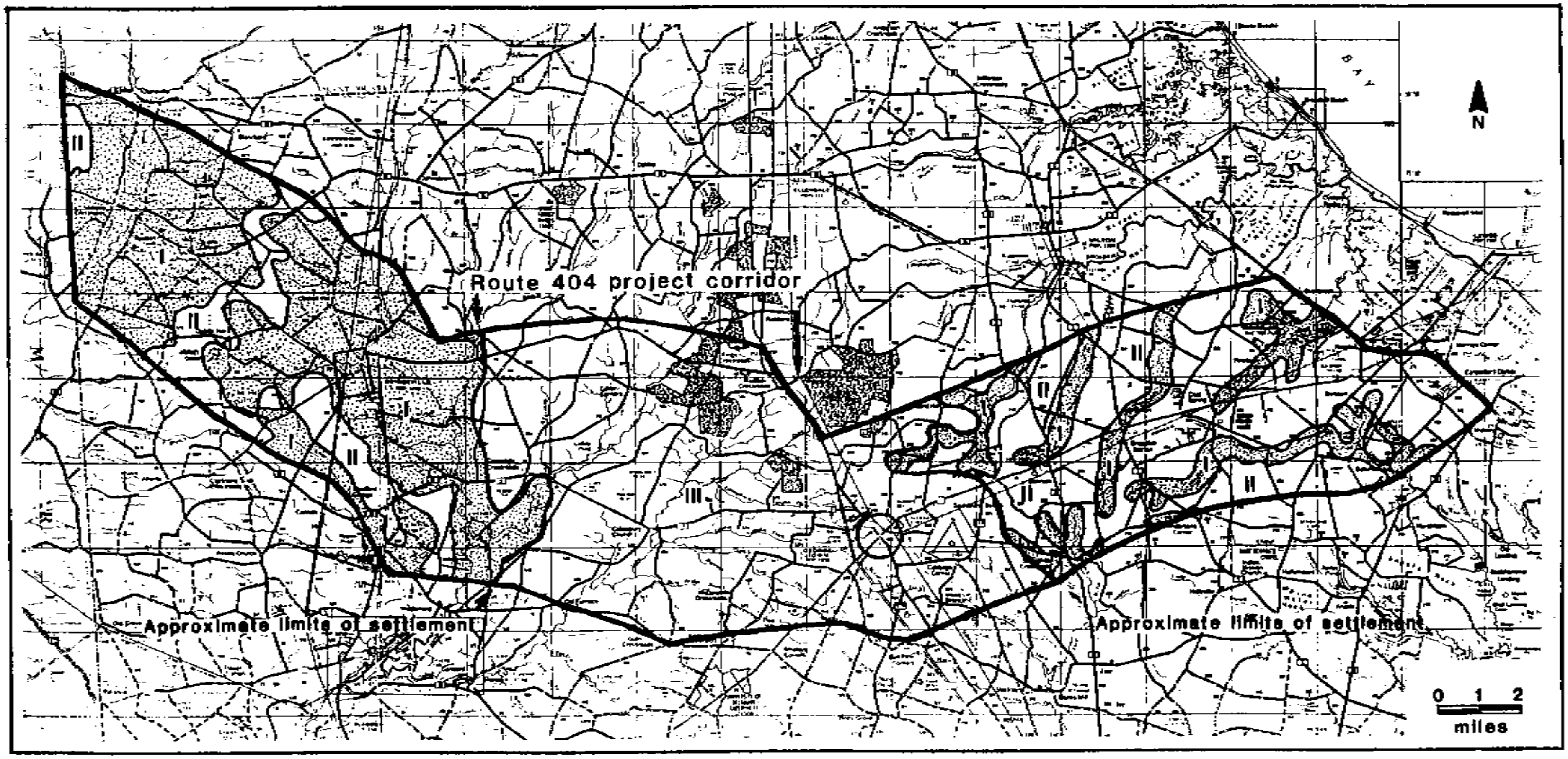
Predictive models and potential site locations for each of the chronological periods are presented below. Sites dating from the 1830 to 1880 and 1880 to 1940+ periods are well-represented by standing structures, and have extensive historical documentation available to aid in site location predictions. Additionally, since the overwhelming majority of known and potential historic resources within the project corridor date at least from the middle of the nineteenth century to the twentieth century, the development of predictive models for these time periods are less critical than for the time between initial settlement of the region in the 1630s to the 1830s. For these periods, Beers'(1868) Atlas and Bausman's (1941) "Map of Land Uses" provide adequate site location data. Conversely, the lack of existing standing structures and known and/or potential archaeological sites within the project corridor that date from the first three chronological periods makes the use of predictive models for site location crucial if these site types are to be adequately identified and sampled. For these reasons, the chronological periods of 1630 to 1730, 1730 to 1770, and 1770 to 1830 are discussed in more detail, and a series of maps are included to indicate areas of varying degrees of potential site locations.

1630-1730

Based on the work of several historical archaeologists and geographers in the Middle Atlantic region and elsewhere (Miller 1980; Wise 1980; Custer, Jehle, Klatka, and Eveleigh 1984:102-113; Lewis 1976: 14-15; Rubertone 1986; Blouet 1972; Earle 1975), settlement patterns in the project corridor dating from this time period were characterized by a reliance on waterways. Historically, settlement was circumscribed by the drainages within the region, such as the Mispillion, Broadkill, Indian River and Bay, Assawoman Bay, and the smaller tributary creeks, such as Cool Spring Branch, Bundick's Branch, Herring Creek, and Lewes Creek. In the western portion of the project corridor, the region claimed during this time period by Maryland and Lord Baltimore, the Marshyhope and the Nanticoke served as the foci of settlement. Limits of historic settlement during this period will be found approximately 10 to 12 miles from the Atlantic Coast, or to the heads of the eastern-flowing drainages in the project corridor, and probably within 1/4 to 1/2 of a mile from the Nanticoke and Marshyhope drainages. Figure 34 presents areas within the project corridor that have varying

FIGURE 34

Potential Site Locations, 1630–1730



KEY TO FIGURE 34

1630-1730:

I. High: These areas contain high potential for historic site locations - they are adjacent to drainages, and sites will be located within 300-500 feet of these waterways in the eastern portion of the corridor, and up to 1/4 to 1/2 mile in the western portion (Maryland lands).

II. Medium: These areas are less likely to be site locations - they are interior settings away from water; probably utilized for grazing and woodlands.

III. Low: These areas are extremely unlikely to contain site locations - these are interior well-drained and poorly drained woodlands with little or no water access. Documentary evidence suggests that this area functioned as a "frontier" zone - with bandits, robbers, and lordless inhabitants.

levels of potential for historic site locations dating from this time period, and additional locational and intra-site data for the 1630 to 1730 period is detailed below.

The Dutch at Lewes, and at other locations on the shores of the Delaware estuary such as Appoquinimink and New Castle, instituted a system of "long lots" which fronted on and extended inland from the waterways (Custer et al. 1984:103; Delaware Division of Historic and Cultural Affairs 1976:15; Wise 1980:7;). Other researchers in the Middle Atlantic have identified a similar "long-lot" system in Virginia, Pennsylvania, and New Jersey (Wise 1980:7). Based on the results of the Atlantic Coast Comprehensive Survey undertaken in the late 1970s, Wise (1980:4) has postulated that historic sites dating from this time period will be located within 300 feet (100 yards) of the drainage on which they fronted.

The long-lot pattern allowed easy access to navigable water, which also served as the primary mode of transportation and communication, since overland travel was severely limited by dense woodlands and marshes. Lots laid out using the long-lot sytem varied considerably in size, those in towns like Lewes being fairly small, while those established by patents from the Penn government on the south side of Indian River contained several hundred acres (Figure 35). In the late seventeeth-early eighteenth centuries, the Penn government also divided land up in haphazard, irregular lots, generally consisting of about 200-acre parcels (Eastburn 1891). Like the long-lot system, these irregular parcels always contained some water source, and usually had a stream serving as a property line, or running through the parcel. Within the project corridor, irregular lots of this pattern will be found along the Nanticoke and Marshyhope drainages, and west of the immediate vicinity of Lewes, around Cool Spring Branch and Bundick's Branch.

Regardless of the lot system used to lay out a parcel, dwellings and "plantations" were generally constructed on well-drained soils with small agricultural field(s) close-by. The low population density of Sussex during this period is reflected in the distances between plantations, which ranged from 0.25 to 1.5 miles from each other (Earle 1975; Hancock 1962). Tobacco was the major agricultural crop at this time, along with livestock raising. Land use of this type suggests that plantations of the period would exhibit an intensive use of the land in the immediate vicinity of the dwelling house and outbuildings, with a patchwork of new and old fields, but significant portions of the property would be kept in woodland

FIGURE 35

Map of Sussex (1740)

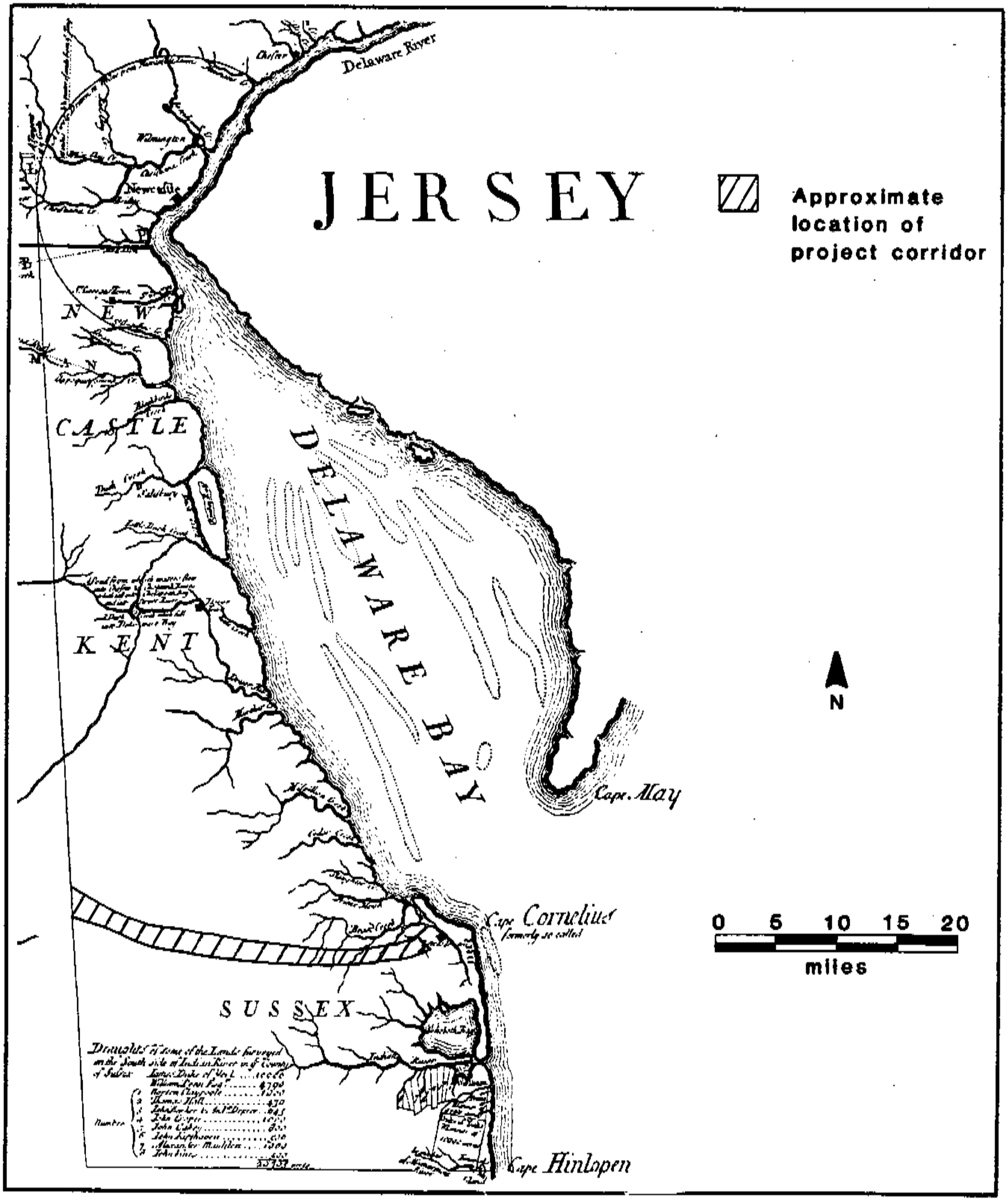
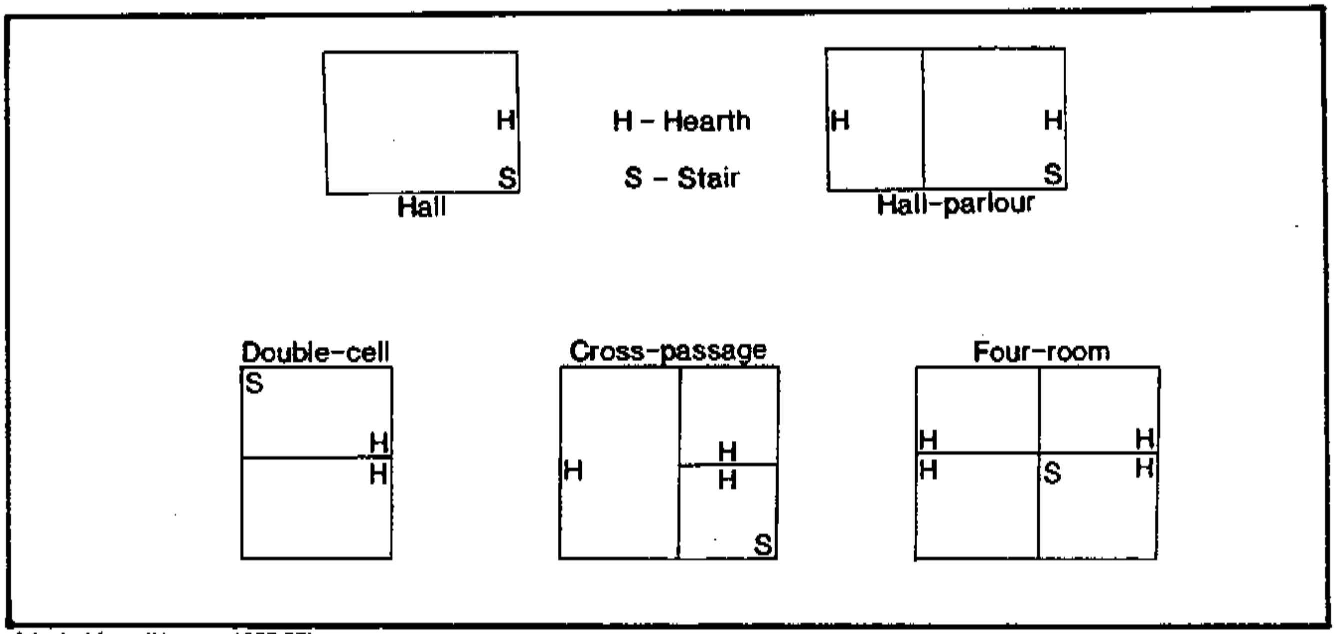


FIGURE 36

Examples of Eighteenth Century Traditional Dwelling Plans in Sussex County, Delaware



Adapted from (Herman 1987:27).

or marsh for cattle forage. Structures present on agricultural complexes dating to this period would have included small dwelling houses generally built of wood (frame or log), and only rarely of brick. Dwelling plans included a range of traditional options such as hall, hall-parlor, double-cell, cross-passage, and four-room (Herman 1987:27) (Figure 36). House foundations were generally of earthfast or impermanent construction, a building style that characterized much of the architecture of North America during this period (Carson et al. 1981; Kelso 1984; Herman 1987:84). A variety of outbuildings such as kitchens, tobacco and grain sheds, milk houses, barns, smokehouses, and meat houses would have been present on the farmsteads (Herman 1987:61-72). Job-specific buildings, such as ship carpentry shops and blacksmith shops, were few in number, and were located primarily in the Lewes area.

The town of Lewes during this period was the only "urban" location in Sussex. Lewes functioned as a center of social, political, economic, and religious activities, and as the entrepot between Sussex County and the upper Delaware communities, overseas to Europe, and the West Indies. In this capacity the town fits Lewis' (1976:14) definition of a "frontier town".

There are only 3 historic sites which date to this time period in the project corridor (Table 8). Two are standing structures --Coolspring Church (S-138) and the Richards House (S-827), both constructed in the first quarter of the eighteenth century; the other is the archaeological site of the Fisher-Martin House (S-137), which was recently moved into Lewes. All three of these sites are listed on the National Register. No other sites dating from this period are presently known in the project corridor, though more could be expected. Specifically lacking are the impermanent sites from the earliest occupation of the area, and their immediate, more durable replacements. Sites dating to this period are therefore significant cultural resources and have high potential within the corridor.

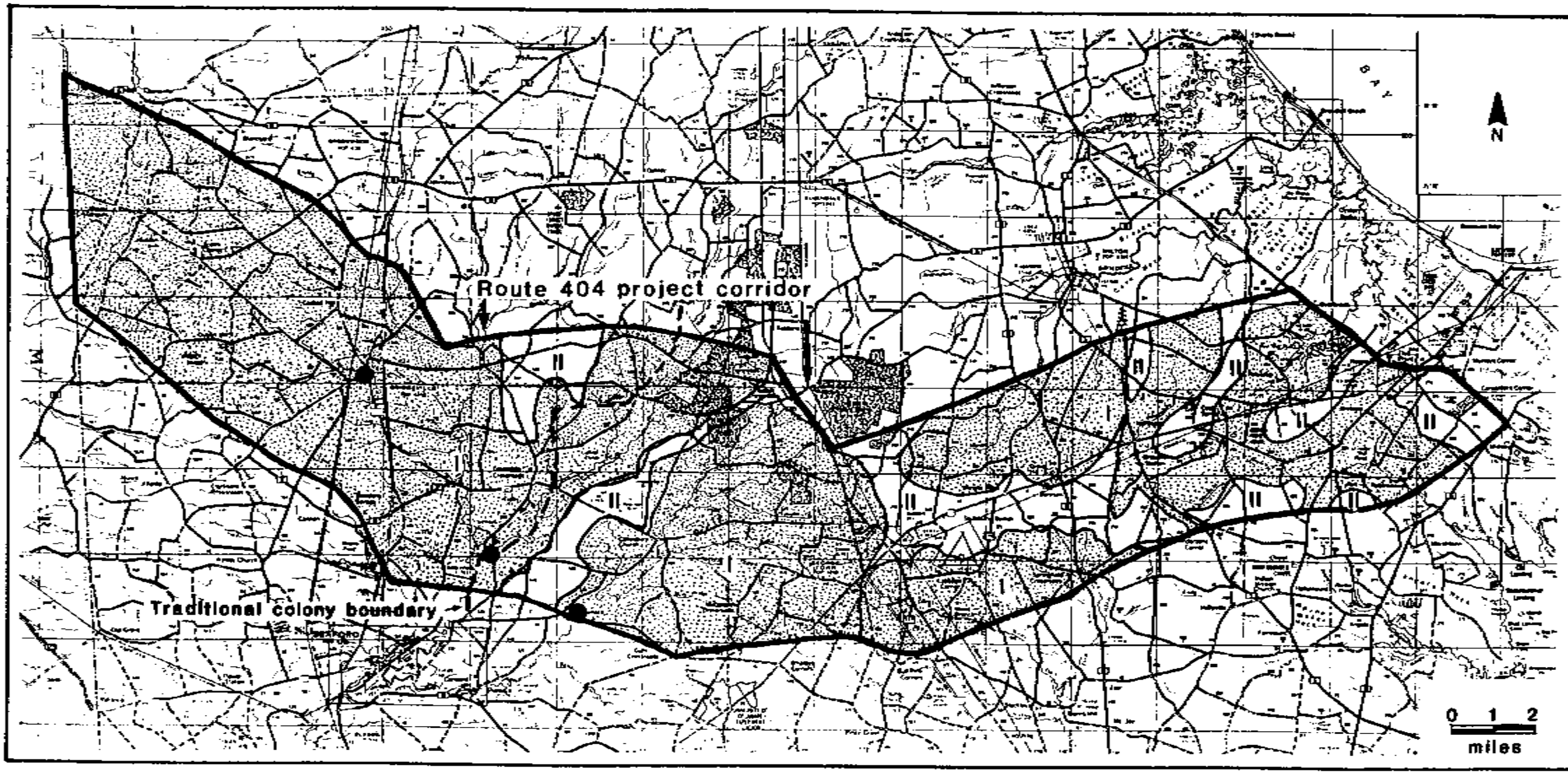
1730-1770

During this time period historic settlement extended westwards across the drainage divide and spread eastward from the Nanticoke and Marshyhope watersheds. The boundary between Maryland and the Three Lower Counties (Delaware) was settled at the close of this period; prior to that time the Nanticoke River and it's tributaries served as the provincial line. Because of this border dispute, there were overlapping land grants issued by both governments in this portion of the project area. The land grant patterns of the previous period continued into this one, with large, irregular parcels often bounded by a water course located in the interior of the peninsula. Water continued to function as the primary transportation and communication medium, and overland routes, though present, were poor. The few roads that did exist were primarily regional connectors, running from the Chesapeake Bay across to the Delaware Shore, and from Lewes up country to Philadelphia, or local secondary roads. Figure 37 presents the areas within the project corridor that have high site probabilities and potentials from this time period.

Settlement pattern during the second quarter of the eighteenth century may have shifted from a water-oriented plantation to a more inland focus (Wise 1980). A settlement shift of this nature was probably due to the change from tobacco agriculture to grain agriculture that occurred in the early eighteenth century in southern Delaware (Munroe 1978). Grain agriculture would have required more extensive land clearing and planting, thus allowing more mobility in dwelling and farmstead location. Documented population increases, caused by immigration from overseas, and overland from the Eastern Shore, would have also contributed to the change in settlement orientation. This change from water to land has been suggested for historic sites

FIGURE 37

Potential Site Locations, 1730-1770



KEY TO FIGURE 37

1730-1770+:

I. High: These areas contain high site location potential. They include the earlier areas of settlement, and reflect the settlement pattern change from water to interior, and from tobacco to grain agriculture.

II. Medium to Low: These areas contain medium to low potential for historic site locations. These are areas of well-drained, droughty soils.

= Early village settlement locations from this period

located along the St. Jones River in Kent County (Wise 1980), but whether the pattern is applicable to Sussex County, and the project corridor in particular, is not known at present.

The change in settlement pattern orientation was reflected in changes in plantation layout and architecture. Starting in the 1740s, Georgian architectural house forms began to appear, and more permanent methods of construction and material types were utilized (Carson et al. 1981; Herman 1987:26,109-110). Livestock raising continued to be an important occupation of the area's inhabitants, and home manufactures were added by the middle of the eighteenth century to the subsistence economy of Sussex's inhabitants (Main 1973; Jordan 1914). Outbuildings reflected the changes in agriculture, with a disappearance of tobacco sheds, the presence of more durable granaries, and barns, and the addition of structures related to home manufacturing, such as weaving houses.

In the western portion of the project corridor, large tracts of forest land and swamp were taken up by the iron companies that were established in the second half of the eigtheenth century.

These iron plantations required large amounts of charcoal and wood supplies to operate, which required extensive tracts of timber. A dispersed pattern of settlement was therefore maintained in the vicinities of the forges, though the population of the forges may have been relatively high, and the furnace complexes themselves contained a variety of structures, such as grist and saw mills, blacksmith shops, dwelling houses, stables, and perhaps churches (Heite 1974; Virginia Gazette 1770; Lewes Presbytery Minutes 1758-1810).

Several small "commercial towns" (Heite and Heite 1986) were established in the project corridor by the middle of the eighteenth century. Commercial towns were those that appeared at prominent crossroads or navigation locations, and served as focal points for the local economy and society, such as Bridgebranch (Bridgeville), Warwick, and at Head of the Broadkill (Milton). These towns usually consisted of a tavern, a bridge or fording place, a grist mill or saw mill, wharves if on a navigable river, maybe a store and perhaps some domestic dwellings. The economic effect of these small towns during this period was probably negligible on the overall region, or on the economy, and Lewes remained the only major urban location in Sussex.

A total of six historic archaeological sites and four standing structures dating from this time period are known to be located within the project corridor. Three of these archaeological sites are located in the western portion of the project corridor, in Nanticoke and North West Fork hundreds; of these, two are forge locations, Old Furnace (S-478) and Unity Forge (S-432). The other three archaeological sites are dwelling locations in Broadkill and Lewes and Rehoboth hundreds. The four standing structures include the Short Farmstead (S-410), a National Register site, and the Hopkins House (S-410), Poplar Level Farm (S-377), and S-5144. All of these are agricultural or dwelling complexes, and date from the 1750s. As with the previous period, archaeological sites from this period are considered to be significant and to contain high potential.

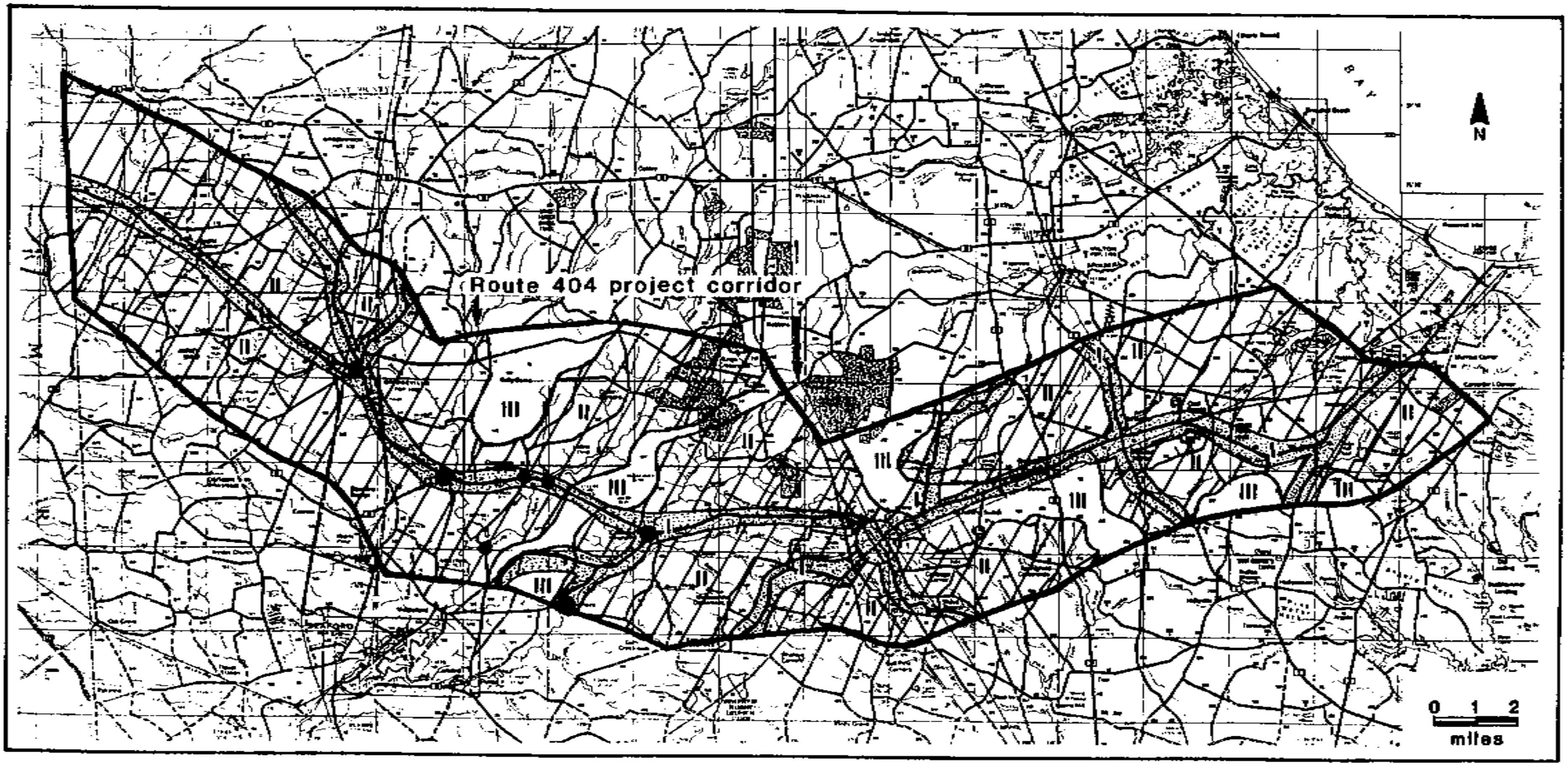
1770-1830

This period of time within Sussex County saw a great deal of change and development of the landscape, as new areas were brought into cultivation, new towns and market centers were founded, and the forests were lumbered off (Figure 38). Subsistence agriculture (predominately corn production), forestry, and home manufactures continued to dominate the economic growth of the project corridor in this period. For the most part, dwellings were constructed of log or frame, with only a few brick houses. Farmsteads were small and averaged few buildings, typically including a house, a smokehouse, one or two corn barns, and perhaps a stable and speciality structure like a loom house or weaving shed. The occupation of the land by tenants rose during this period, and many of the farms in the project corridor were considered to be "out plantations", or tenant-occupied farms (Herman 1988; Garrison 1988).

The population of the county grew from about 14,000 in 1775 to over 24,000 in 1790. Though the population fluctuated throughout the remainder of the period, it generally rose, and

FIGURE 38

Potential Site Locations, 1770-1830



KEY TO FIGURE 38

1770-1830:

I. High: These areas represent zones of high site location potential for this period. The zones are located along the major transportation routes that developed in the interior after the founding of Georgetown in the early 1790s. Sites will be oriented towards the roads, though not necessarily immediately adjacent to them.

II. Medium: These areas represent zones of medium historic site location potential. They are located inland from the zone I areas, and were utilized during the period as lumbering, grazing, and some farming land. Within this zone, historic sites will most likely be oriented to secondary overland transportation routes, and possible to water routes.

III. Low: Areas that are representative of zones of low historic site location potential. These zones are located in areas of exceedingly well-drained soils, where corn agriculture would have been difficult. Where zone I areas cross these lands, the potential for site locations may be higher.

= Settlement areas - these are zones of increased settlement or nodal activity, such as Bridgebranch (Bridgeville), the Forge locations (Collins Forge, old Furnace, Gravelly Delight Forge), and Mill seats (Collins Mill, Ross' Mill [near Woolenhawk]).

reached over 27,000 by 1830. The early growth may be attributable to the acquisition of Maryland lands in the 1770s (the settling of the boundary issue), and the rise in population over time is indicative of the increased development of agriculture, the rise of tenancy, and home manufactures in the region (Herman and Siders 1986:79).

The founding of the "planned town" of Georgetown in the 1790s was a significant event in the history of Sussex, because it reflects the changing social and economic environment of the period. By the start of the nineteenth century, Georgetown was followed by the establishment of other centralized market place towns like Seaford, Laurel, Milton, and Millsboro, and these towns stimulated the growth of the interior portions of Sussex County. Although not large by regional standards, these commercial towns became foci of service and merchant locations, and shops, stores, wharves, and taverns were located in them. The iron industry located in the Nanticoke watershed began to decline in economic importance during this period, and the lands sold off for farming and lumbering. Mill seats became significant locations in the project corridor during this period, and often were the center of other service-oriented structures, such as blacksmith and wheelwright shops, and taverns. Religious diversity in the County was reflected by the erection of numerous churches and chapels in interior locations throughout the project corridor, most notably Methodist and Baptist churches.

Water-oriented transportation and commerce remained the primary means of business and communication, with two major foci of shipping in Sussex. The towns of Seaford and Laurel were oriented towards the south and the Chesapeake, while Indian River, Rehoboth Bay, Milton and Lewes faced the Atlantic and were part of the economic hinterland based on Philadelphia.

During this period the landscape of the project corridor was transformed, with more land cleared and put into agricultural production, an intensive deforestation of the interior portions of the county, and improvements in the internal transportation network (Herman and Siders 1986:80). All of these changes were reflective of larger-scale significant economic and social changes, as more land was occupied by the poorer classes of farmers and tenants.

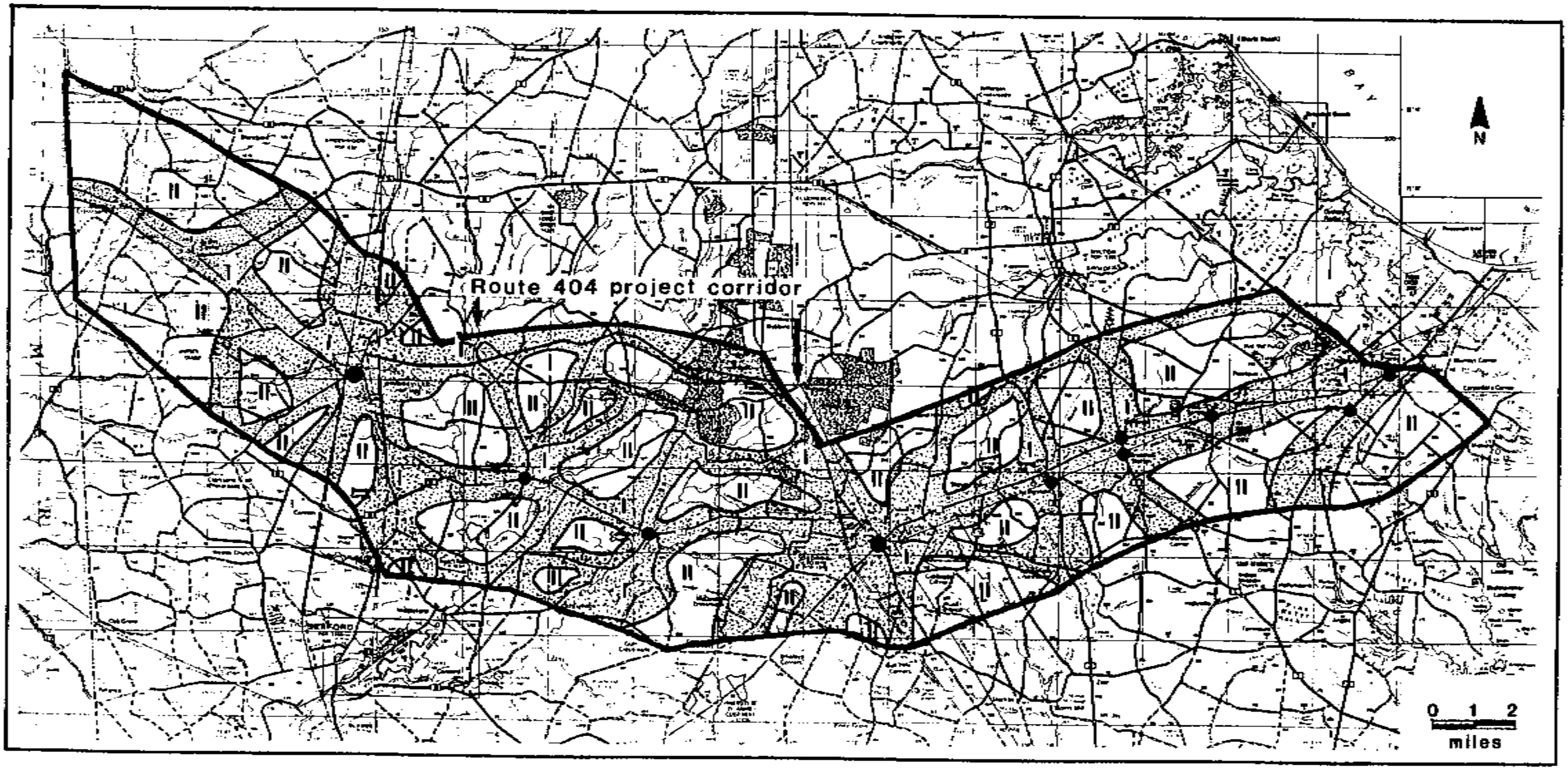
There are at present 25 potential historic archaeological site locations within the project corridor (Table 8). The largest number of these are located in Northwest Fork Hundred, and include agricultural complexes and dwellings, and two saw mills. Nanticoke Hundred contains five potential site locations, including two forge locations, a bridge, and a grist mill and mill dam. The remainder of the hundreds within the project corridor have four or less sites. Though there are comparatively more potential sites within the corridor dating from this time period than from the two earlier periods, these sites locations are well-documented, and are considered to be significant and to have high potential.

1830-1880

It is during this time period that the amount of cleared land within Sussex County reached its apex, and with this clearing a rise in population and a revolution in farming (Figure 39). Changes in agriculture in Sussex were manifested during this period by the reclamation of waste and forest lands, and by the ditching and draining of low swamp lands. Major transportaion changes, most obviously the arrival of the railroad in the County in the late 1850s, spurred the further development of the interior of Sussex, forcing the occupation, clearing and farming of previously marginal lands. Within the project corridor these lands are located at the drainage divide, south and west of Georgetown in the vicinity of Flea Hill, and east as far as Sand Hill (Bausman 1941).

FIGURE 39

Potential Site Locations, 1830–1880



KEY TO FIGURE 39

1830-1889:

I. High: These areas represent zones of high site location potential for this period. The zones are located along the primary and secondary transportation routes in the Corridor. The construction of the raliroad(s) in the Corridor during this period provided new impetus for settlement, and change in agricultural practices from predominantly corn agriculture to market gardening and truck farming. Large numbers of new roads were established during this period, connecting the interior areas with transportation and service centers, like towns and railroad depots. Water transportation, though still important, has less effect on the project corridor, and serves mainly as attractive shipping points at Seaford and Milton, both outside the Corridor.

II. Medium: These areas represent zones of medium site location potential. Sites in these zones, and one located to the interior of zone I areas. These zones are occupied mostly by agricultural complexes and tenant houses, and in many cases will be located on new or recently reclaimed or marginal lands. Other site types which may be found in this zone include steam saw mills, lumber complexes, and grist mills. The new truck farming and market gardening are the catalyst for opening up previously unfarmed lands.

= Settlement/villages. These are areas of increased nodal activity, particularly related to changing transportation patterns. Special locations from this period include the railroad depots, like Bennum, Harbeson, and Coolspring, and the black community of Belltown. Outside of the Corridor are the towns of Seaford, Lewes, and Milton, which directly effect the transportation network within the Corrridor.

During this period, the number of new roads constructed or created within the project corridor was greater than in any previous period, particularly roads which ran from interior locations to railheads and stations. Land was used for truck farming and orchard crops such as peaches and strawberries, though subsistence agriculture and corn production was still predominant as a major agricultural product of the county.

Subsistence farming continued to reinforce dispersed settlement, but the housing stock in the project corridor improved during this period. By 1860, earlier dwellings were being replaced and enlarged by two-story hall-parlor or center-passage single pile dwellings, with barns, corn cribs, and stables as outbuildings (Herman and Sider 1986:87).

The railroad directly created several new town locations in or near the project corridor, such as Greenwood and Ellendale, and at the same time allowed other cross-roads locations to decline in importance. These towns provided new foci for urban settlement, and railroad oriented services and other emerging industries were constructed at these locations. In addition, several religious "new towns", such as Rehoboth, were founded during this period. Earlier churches were also replaced or enlarged at this time with more fashionable stuctures (Herman and Siders 1986:87).

All of these changes -- population increases, new transportation routes, gradual shifts in agriculture from subsistence to market gardening, land clearing and reclamation, and the establishment of new urban centers -- are suggestive of changing social, cultural and economic values within Sussex County. Though agriculture was still the predominant occupation of the people of the project corridor, significant urban locations contrasted with the rural nature of the region, and the rise of the tourism industry reveals changes in social perceptions of leisure time.

Settlement patterns during this period are most easily viewed by examining Beers' Atlas (1868), which is the first detailed map of the project corridor. There are a total of 367 potential historic archaeological sites dating from this period within the corridor (Table 8). The number of sites dating from this period is clearly a bias in the data. Nearly a third of these historic sites are located in Nanticoke Hundred, followed by Northwest Fork Hundred, Georgetown Hundred, and Lewes and Rehoboth Hundred. These numbers are reflective of both the amount of project corridor passing through these hundreds, and the relative levels of population growth and historic development for these hundreds. The overwhelming majority of site types within the corridor dating from this period are identified as agricultural complexes (288), with considerably fewer numbers of dwellings (12), dwelling complexes (14), schools (10), and family cemeteries (10). It should be noted that many of these historic sites were probably occupied at an earlier date than the 1830-1880 period, but that this is the earliest documentary data available for these sites.

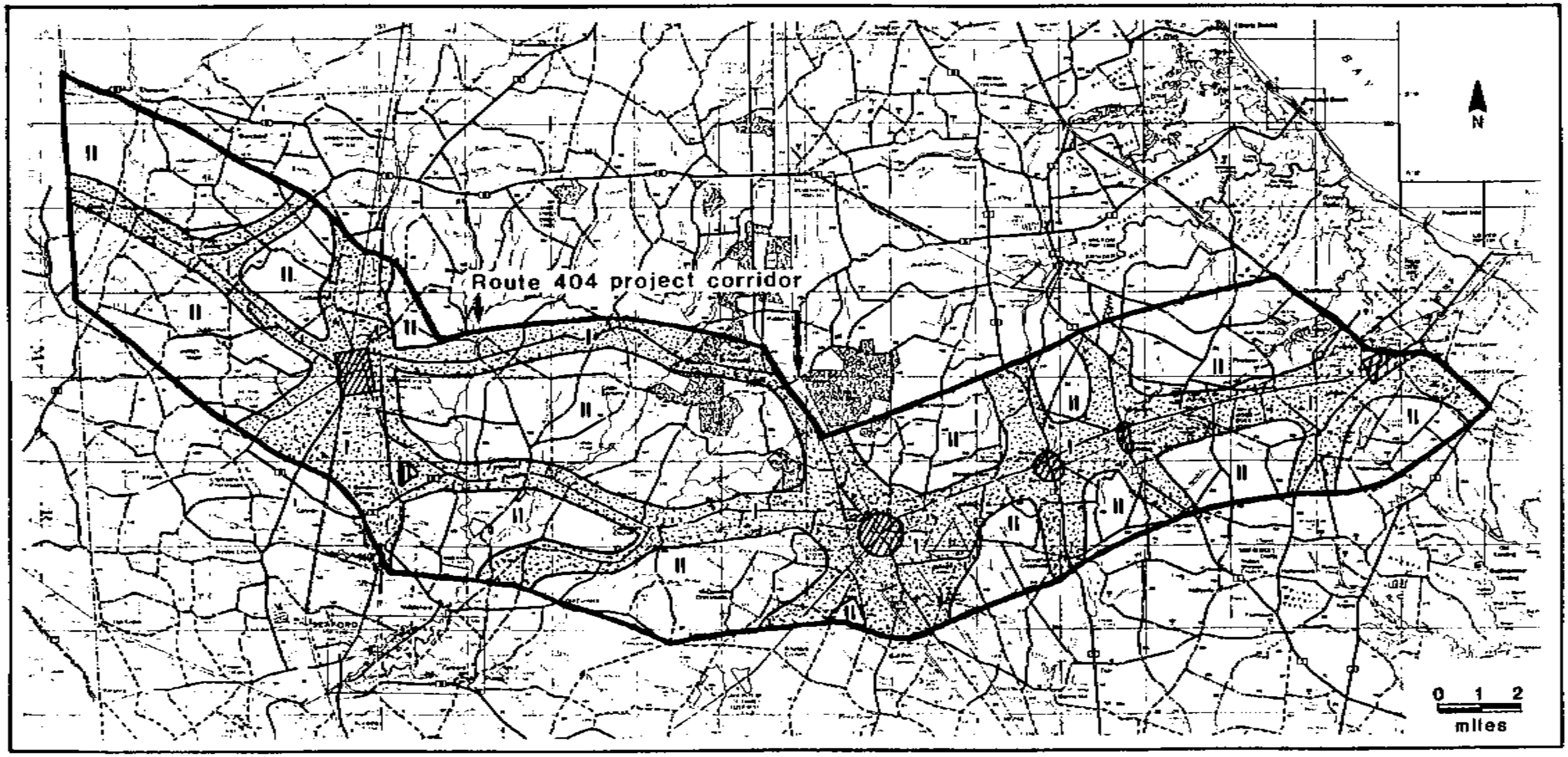
Issues of historic significance and potential for sites dating to this period should be addressed on a case-by-case basis, taking into consideration site type, the integrity of the archaeological remains, number of sites of this type, the presence of standing structures of the same type, associated outbuildings or architectural remains, and the like.

1880 to 1940

Herman and Siders (1986:93) have characterized the existing landscape of the region as one that is a reflection of the agricultural practices and markets that were created or practiced during the 1880 to 1940 period (Figure 40). The most obvious

FIGURE 40

Potential Site Locations 1880-1940+



KEY TO FIGURE 40

1880-1940+

I. High: These areas represent zones of high site location potential for this period. As in the previous time period, the zones are located along primary transportation routes, particularly strip-development along Route 13 and Route 113. Alterations in agricultural practices, particularly the shift to a "corn - soybean - chicken complex", the important perishable produce industry, and improving transportation routes and facilities serve to concentrate settlement along the roadways and around the growing urban centers of Georgetown and Bridgeville, and to a lesser extent around Gravel Hill, Bennum, Broadkill Station/Harbeson, and Five Points. This zone has contracted somewhat from the previous period, but population density overall has risen due to the abandonment of interior areas.

II. Medium/Low: These areas represent zones of medium to low site location potential for this period. The changing nature of agricultural production in the Corridor during this period resulted in the abandonment of agricultural complexes associated with marginal lands or poorly drained areas, and the improved transportation routes re-oriented settlement from these interior areas. Much of this land, particularly in the central and western portion of the project corridor, is timber land, and is used for lumbering.

= Urban centers - these are the significant urban locations in the project corridor, and include Bridgeville, Georgetown, and Five Points.

changes that can be seen today are the mechanical cultivation of large field areas, natural forests confined to watercourses or nature preserves (such as Ellendale and Redden State Forests), and a network of roads which serve to shorten the distance between the "backcountry" and towns in the county. There has been a decline in forest area in the county, and an increase since 1940 of the number of channelized and ditched drainages. Bausman (1941:7) has identified a 25% decline in the number of farms in Sussex since 1880, attributable to the exhaustion of marginal soils for farming.

The existing housing stock within the project corridor dates from this period or later, including barns, corncribs, sheds, perishable-related buildings (potato houses, etc.), chicken houses, tractor sheds, and other sheds. In fact, about 77% of the housing stock in Sussex County was constructed after 1940, as either new construction or the enlarging or replacing of older buildings (Ames et al. 1987:58).

The rise in popularity of the automobile as a means of transportation has had a profound effect on the county, especially with the creation of new roads, such as Route 13 and Route 113. New roads in turn have provided new economic opportunities, particularly in the service-related industries (service stations, resturants), which is evident by the "strip development" in sections of the project corridor along major regional connectors. Improved transportation also sparked the further development of market gardening and perishable crops, as well as continued growth of the tourism industry.

The development of the broiler industry which began in the 1920s has experienced a tremendous change from the previous agricultural methods followed in the area, and in land use patterns related to chicken farming. Large chicken houses are readily apparent on the landscape, and are a ubiquitous part of the agricultural growth of Sussex County.

There are twelve known archaeological sites dating to this time period in the project corridor (Table 8). All of these were identified from the BAHP inventories. Considerably more standing structures dating to this time period are present within the project corridor and can provide more significant cultural information than archaeological sites of the same time. Thus archaeological sites dating to this time period are not considered to be as significant as sites from former periods, and the standing structures offer better potential for data retrieval.

Unknown Dates: Cemeteries

There are twenty-seven historic sites in the project corridor for which no date is known at present. These sites are exclusively family and church cemeteries (Table 8). Identification of these sites was accomplished by oral reports, by the BAHP site files, and by examination of the USGS topographical maps. Family and church cemetery sites are significant cultural resources within the project corridor, and have the potential to provide important information to the existing body of data regarding historic Delaware demographics. They are significant because they graphically illustrate the "continuity" over time of the inhabitants of Sussex County, a phenomenon noted by Bausman (1941) nearly fifty years ago. These sites are rather special cultural resources and should be field checked and have dates obtained for their use and occupation.

MANAGMENT CONSIDERATIONS AND RECOMMENDATIONS

The previous sections of this report have focused on compiling and listing the known and potential cultural resources for the project corridor, and has provided a prehistoric and historic cultural context in which to study them. In this section of the report three issues will be addressed: 1)